

A STUDY OF THE BRACHIOPOD GENUS PLATYSTROPHIA

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INTRODUCTION.

The brachiopod genus *Platystrophia*¹ is of interest because of the abundance of its species and the great variation exhibited in their development. Early investigators differed considerably as to the relationships of this group of brachiopods and referred its species to *Terebratulites*,² *Terebratula*,³ *Porambonites*,⁴ *Atrypa*,⁵ *Spirifer*,⁶ and *Delthyris*.⁷ The peculiar granular surface and general outline of the shell led most early writers to refer its species to *Spirifer* and *Delthyris*, but the intimate structure is clearly distinct from all of these genera.

In 1848 Davidson demonstrated⁸ that the internal characters of this group of shells were those of *Orthis* and several contemporary investigators followed his interpretation. In 1850 King⁹ proposed the name *Platystrophia* for this group of *Orthis* with *Terebratulites biforatus* Schlotheim as the type. In America early investigators referred these shells to *Delthyris* and *Spirifer*,¹⁰ and later to *Orthis*.¹¹

¹ Πλατυς, wide; στροφειν, to turn (as a hinge).

² Schlotheim, Petrefaktenkunde auf ihr jetz. Standpunkt, 1820, p. 265.

³ Von Eichwald, Nt. Schizze von Polodien, 1830, p. 202.

⁴ Pander, Beitr. zur Geognosie Russlands, 1830, p. 96.

⁵ Illinger, Lethaea Succica, 1837, p. 76.

⁶ Von Eichwald, Silurische Schichten-System von Estland, 1840, p. 144.—Castelnau, Essai sur le Syst. Silur. de l'Amérique septentrionale, 1843, p. 42.—Phillips and Salter, Mem. Geol. Surv. United Kingdom, vol. 2, 1848, p. 293.—McCoy, British Palaeoz. Fossils, 1852, p. 192.

⁷ De Verneuil, Géol. de la Russie, vol. 2, 1845, p. 135.—McCoy, Syn. Silur. Fossils Ireland, 1846, p. 37.

⁸ Davidson, Bull. Soc. Géol. France, ser. 2., vol. 5, 1848, p. 323.—Quenstedt, Handb. der Petrefaktenkunde, 1851, p. 436.—Davidson, Introduction British Foss. Brachiopods, pl. 8, 1853, figs. 146-148.—Salter, Murchison's Siluria, ed. 2, 1859, p. 210.—Lindstrom, Gotland's Brachiopoder, 1860, p. 371.—Salter, Mem. Surv. United Kingdom, vol. 3, 1866, pp. 259, 267, 276.—Davidson, British Silurian Brachiopoda, 1871, p. 268.

⁹ Mon. Permian Fossils England, p. 106.

¹⁰ Emmons, Geol. New York, Rep. Second Dist., 1842, p. 396.—Conrad, Journ. Acad. Nat. Sci. Philadelphia, vol. 8, 1842, p. 260.—Hall, Geol. New York, Rep. Fourth Dist., 1843, p. 70.—Owen, Geol. Expl. Iowa, Wisconsin, Illinois, 1844, pl. 15.—Hall, Nat. Hist. New York, Pal., vol. 1, 1847, p. 131; vol. 2, 1852, p. 192.—Rogers, Geol. Pennsylvania, vol. 2, 1853, p. 820.

¹¹ Billings, Canadian Nat. Geol., vol. 1, 1856, p. 206.—Hall, Twelfth Rep. New York State Cab. Nat. Hist., 1859, p. 66.—Billings, Geol. Canada, Rep. Prog., 1863, p. 167.—Nicholson and Hinde, Canadian Journ., 1874, p. 153.—Meek, Geol. Surv. Ohio, Paleont., vol. 1, 1873, p. 114.—James, Cincinnati Quart. Journ. Sci., vol. 1, 1874, p. 20.—White, Geogr. and Geol. Expl. west 100th Merid., 1875, p. 74.—Nicholson, Rep. Pal. Prov. Ontario, 1875, p. 16.—Miller, Cincinnati Quart. Journ. Sci., vol. 2, 1875, p. 25.—James, The Paleontologist, No. 1, 1878, p. 7.—White, Second Ann. Rep. Indiana Bur. Stat. and Geol., 1880, p. 487; Tenth Rep. State Geol. Indiana, 1881, p. 119.—Foerste, Bull. Sci. Lab. Denison Univ., vol. 1, 1885, p. 80.—Nettelroth, Kentucky Fossil Shells, 1889, p. 35.

It was not until after 1883 that King's term *Platystrophia* came into general use.¹

Several recent investigators have added much to our knowledge by their specific interpretations, among whom Prof. E. R. Cumings and Dr. A. F. Foerste² are most prominent. Professor Cumings published a detailed study on the Morphology of the Genus³ which brought out the fundamental lines of evolution and variation. The aim of the present paper is to corroborate and add some facts to the work which he has done.

The mutability of species has been accepted by most investigators since Darwin published his "Origin of Species" in 1859. However, many systematists to-day find difficulty in including more than one species in a well-graded series, even though the extremes are quite different. When individuals possessing common characteristics and possessing the tendency to acquire certain other characteristics are subjected to varying influences they develop differentially. This results in groups which differ to a greater or less degree. These groups are regarded by the writer as species.

The material on which this study is based belongs for the most part to the United States National Museum. It consists of about 4,000 specimens from various points in North America and Europe. The specimens were mainly from the Ulrich collection, with additions made in recent years by various members of the museum paleontological staff.

In addition to these, several hundred *Platystrophia*s from the Paleontological Museum of Columbia University were at the writer's disposal. Dr. A. F. Foerste also kindly presented about 500 specimens from the Ohio Valley and from Michigan to the United States National Museum in order to further the present study.

With the fullest appreciation of Professor Cumings's work on the "Morphogenesis of *Platystrophia*" the writer gladly acknowledges her indebtedness to him for the inspiration received from that valuable work. He has also been of great service in offering helpful suggestions and criticisms. Acknowledgments are extended to Dr. E. O. Ulrich, of the United States Geological Survey, who supplied information which could not be secured from any other source. The writer desires to express her appreciation to Dr. R. S. Bassler, curator of

¹ Zittel, Handb. Pal., vol. 1, 1880, p. 675.—Hall, 36th Rep. N. Y. State Mus. Nat. Hist., 1883, p. 34; Rep. N. Y. State Geol. for 1882, 1883, p. 34.—Waagen, Mem. Geol. Surv. India, Pal. Indica, ser. 13, vol. 1, 1884, p. 549.—Shaler, Mem. Kentucky Geol. Surv., vol. 1, pt. 3, 1887, pp. 43, 44.—Hall, Bull. Geol. Soc. America, vol. 1, 1889, pp. 19, 20.—Hall and Clarke, Pal. New York, vol. 8, pt. 1, 1892, p. 200.—Winchell and Schuchert, Geol. Minnesota, vol. 3, 1893, p. 454.—Hall and Clarke, Eleventh Ann. Rept. New York State Geol., 1894, p. 268.—Koken, Die Liefossilien, Leipzig, 1896, p. 235.—Schuchert, Bull. U. S. Geol. Surv., 87, 1897, p. 303.—Wysogorski, Zeits. d. d. Geol. Gesell., vol. 52, 1900, p. 234.—Cumings and Mauck, Amer. Journ. Sci., ser. 4, vol. 14, 1902, p. 9; Cumings, Amer. Journ. Sci., ser. 4, vol. 15, 1903, p. 1.—Grabau and Shimer, N. A. Index Fossils, vol. 2, 1907, p. 257.—Cumings, Thirty second Ann. Rep. Dep. Geol. Nat. Res. Indiana, 1908, p. 891.—Schuchert, Zittel Eastman Textb. Pal., 1913, p. 381.

² Bull. Sci. Lab. Denison Univ., vol. 1, 1885, p. 80.

³ Amer. Journ. Sci., ser. 4, vol. 15, 1903, p. 1.

paleontology, United States National Museum, for his suggestions and criticisms in the preparation of the paper. The writer is under deep obligations to Prof. A. W. Grabau of Columbia University, under whose direction this study was begun.

GENERIC CHARACTERISTICS.

Most paleontologists have based their classifications on adult characters alone. If a classification is to express generic relationship and not merely represent a group of morphological equivalents, the early growth stages must not be neglected, and should indeed be regarded with great care.

The writer was unable to secure young specimens of *Platystrophia*. Professor Cumings has, however, demonstrated¹ that a specimen between 0.66 mm. and 1 mm. in length was "markedly transverse, the greatest breadth about one-third of the way from the beaks to the front margin. The posterior margin (cardinal line) is straight, and the anterior semielliptical. The greatest height is at the beaks which project slightly beyond the area, but are not incurved. The area is considerably less than the width of the shell at the hinge, and the large foramen is about equally shared by the two valves. At the apex of the ventral foramen is a small callosity. No deltidium was observed." The young stages are well preserved in many adult specimens and thus furnish a permanent record of the entire life history. These specimens show a smooth shell next to the beak. Very soon, however, plications appear, eight on the brachial valve and nine on the pedicle valve. The furrow separating the two centrally located plications of the brachial valve is deeper than the others and forms a median sinus, and the centrally located plication on the pedical valve is larger than the others and forms a fold.

This development is followed by the depression of the area occupied by the pedicle fold and the elevation of the area occupied by the brachial sinus thus forming the true pedicle sinus and brachial fold. The early nepionic fold becomes a plication occupying a median position in the true sinus and the two plications bordering the early nepionic sinus become plications on the true fold.²

In discussing this development Winchell and Schuchert say, "* * * In several immature individuals it has been observed that in the early neologic stage the beaks are strongly elevated, probably erect, and each has a very large open delthyrium, surface smooth at first, but gradually developing eight plications and a mesial sinus in each valve. The sinus in the dorsal valve is bounded

¹ Amer. Journ. Sci., ser. 4, vol. 15, 1903, pp. 2-4.

² For a detailed discussion of the early stages of the genus see Cumings, Amer. Journ. Sci., ser. 4, vol. 15, 1903, p. 3.

by two elevations which become plications and between them is soon developed a single costa which immediately bifurcates. The four plications increase in strength and become strongly elevated as they proceed to the anterior margin producing the conspicuous fold of this valve."¹ Mature specimens which have well preserved beaks show the presence of a distinct fold on the pedicle valve and a distinct sinus on the brachial valve in early nepionic development as was first pointed out by Professor Cumings.

During the early neanic stage the shell takes on group characteristics. These groups will be described later as the Uniplicate, Biplicate, and Triplicate Groups.

In late neanic and early ephobic development the changes which take place vary with different species and are of specific, varietal, or individual value.

Adult specimens show the hinge-line to be long and straight. Generally it about equals the width across the middle. A few species have the hinge-line much less and a few others much greater than the width farther forward. The cardinal areas are common to both valves and are about equally developed. That of the pedicle valve is generally somewhat the broader. Each valve has an open delthyrium, of which the one in the pedicle valve is the larger.

The teeth are thick and prominent. In the brachial valve a cardinal process is sometimes present as a short, slender, vertical ridge in the roof of the open delthyrium. The dental sockets are small and the crural plate large and strong. The muscular scars are usually excavated into the shell substance. They are small and are not easily separable into their respective parts. An exception is found in *Platystrophia ponderosa*, in which the scars are separated by a septum in the brachial valve, extending toward the front as a low ridge and dying out before reaching the front.

About one-third of the distance from the beak the septum sends off ridges at right angles to the general direction of the septum (pl. 52, fig. 10).

Both valves are convex. They vary from flatly to strongly convex. The brachial valve may about equal the convexity of the pedicle valve, but it is generally greater. This valve carries a median fold, which may be broad, round, or flat, and but slightly raised above the general convexity of the valve; it may be broad, round, and much elevated, or it may be compressed and greatly elevated above the general convexity.

The pedicle valve has a median sinus, which may be broad and shallow, broad and deep, or narrow and deep. In some species the depth of the sinus is in proportion to the height of the fold, but some

¹ Geol. and Nat. Hist. Surv. Minnesota, vol. 3, pt. 1, 1893, p. 456.

specimens show that the sinus is proportionally deeper than the height of the fold. This is accomplished by the compression of the pedicle valve, which results in a greater elevation of the slopes next to the sinus.

With few exceptions the surface of both valves is marked by strong plications, which are generally sharp. *Platystrophia fernvalensis*, new species, from the Fernvale of Cape Girardeau, Missouri, is striated, but next to the beak these striae merge into broad plications. The genus is extremely variable in form, size, and number of plications. Form and size are reasonably constant, but the number of plications varies considerably within the limits of the species.

The surface layer of the shell is finely granulose. This feature is not always evident if the surface layer has been subject to abrasion. The inner surface is finely punctate.

Old age is indicated by increase in gibbosity, thickening of the shell, strong growth varices, and loss of characters of low taxonomic rank.

TYPE OF THE GENUS.

King took as the type of his genus, *Terebratulites biforatus* Schlotheim. This species was described in 1820 as follows: "Mit ganz gleichen, breiten, länglichrunden Hälften, deren Schnäbel gleichförmig gewölbt und auf beyden Seiten durchbohrt sind. Die Oberschaale mit einer breiten concaven Rückenfurche, die untere Hälfte mit convex hervorstehenden Rücken. Beyde Hälften gleichförmig der Länge nach gestreift, mit ziemlich tiefen Zwischenfurchen. Ausserordentlich selten."¹

Schlotheim's type material consisted of one specimen which was not figured. His description is too general for application to any particular species, and as a result paleontologists have not been able to come to any definite conclusion as to the specific denomination of the shell.

M. de Verneuil says² that Von Buch saw Schlotheim's type in the Berlin Museum, and reported the distinctive characters to be the presence of five ribs in the sinus, and the width proportionally greater than the other species of the genus then known. There are individuals of nearly every species and every variety of this genus which have four, five, or more plications in the sinus, and transverse forms are common. There are subquadrate specimens with five plications in the sinus and transverse specimens with five plications in the sinus, so that the characteristics cited are not sufficient to constitute a species.

¹ Schlotheim, Die Petrifactenkunde auf ihrem jetzigen Standpunkte durch die Beschreibung versteineter Schalle, 1820, p. 265.

² De Verneuil et De Keyserling, Geol. Russia, vol. 2, p. 138.

Davidson says: "We certainly have the type *biforata* and the variety *lynx*, but these two seem with us so intimately connected that I have combined them under Schlotheim's single designation; * * *"¹

Davidson figures² his specimens as *Platystrophia biforata* and varieties of that species. The origin of the plications of the fold and sinus as shown in figs. 11, 11*a*, 11*b* is distinctly different from that shown in figures 12, 14, 15, 25. The origin of the plications of the other specimens is not determinable with certainty. This difference in origin is of great importance as it takes place very early in the development. Members of the same species would necessarily have a uniform ontogeny.

McCoy describes *Platystrophia biforata* as "having the mesial fold wider, and less elevated, bearing usually from six to nine ribs, at six lines or less from the beak, and five to seven in the sinus; the lateral ribs narrow, simple and from nine to twelve on each side, at six lines from the beak."³ This description does not define any particular form as there are individuals of nearly every species of the genus which show this characteristic.

As it is impossible to determine what Schlotheim's type-specimen was it can not stand as a type of the genus. *Platystrophia laticosta* Meek is well known to all investigators of Ordovician paleontology. As it possesses all the qualities necessary for a genotype, it is suggested that future workers regard it as such.

RELATION TO OTHER ORTHIDS.

Professor Cumings has shown that the nepionic development of *Platystrophia* is identical with that of *Orusia lenticularis* variety *lycoides* Matthew and concludes that that species is the ancestor of the genus.⁴

Eoorthis of the Upper Cambrian has the physiognomy of this genus and has been confused with it. This resemblance is of little importance. It is, however, of interest that in this genus the sinus is in the brachial valve and the fold on the pedicle valve. This recalls the early development of *Platystrophia*, in which the pedicle valve bore a fold and the brachial valve a sinus. In Monograph 51, United States Geological Survey (pl. 93, fig. 3), *Eoorthis? diablo* (Walcott) is represented. The specimen seems to have been smooth at the beak. Very near the beak broad undulations arise and extend to the frontal margin. This agrees with the early nepionic development of *Platystrophia* and further investigation is likely to bring to light close relationships between the two genera.

The resemblance of *Plectorthis* to *Platystrophia* has also been demonstrated by Professor Cumings.⁵ He says: "If the sinus and

¹ British Fossil Brachiopoda, 1851-1855, p. 271.

² Idem, pl. 38.

³ British Pal. Fossils, pp. 192, 193.

⁴ Amer. Journ. Sci., ser. 4, vol. 15, 1903, p. 5.

⁵ Idem, p. 11.

fold are disregarded, the neanic *Platystrophia* is almost a *Plectorthis*. There is little doubt that when the nepionic shell of *Plectorthis* is discovered it will be found to be quite indistinguishable from the nepionic shell of *Platystrophia*, since the two present at the beaks almost identical characters. * * * *Plectorthis* may therefore represent an offshoot from the *Platystrophia* group near its initiation or, as suggested above, it may have been separately derived from the *Orthis lenticularis* stock."

Beecher has shown that *Platystrophia* has all the characters necessary for the ancestor of *Bilobites*.¹ Professor Cumings carried this investigation somewhat further and found that the nepionic stage of *Bilobites* is almost identical with that of *Platystrophia crassa* in everything except size. He says: "The median plication of the sinus of uniplicate and triplicate types of *Platystrophia* is a character that is never absent, whatever other modifications may affect the shell; the presence of this persistent character in a derived genus is to be expected, and affords, together with the evidence from development, a virtual demonstration of the derivation of *Bilobites* from *Platystrophia*."² The ancestor of *Bilobites* must have been uniplicate and he regards *Platystrophia crassa* as the most likely ancestor.

As specialized forms of this species are taking on declining characters, it is likely that *Bilobites* originated from one of the least specialized members.

GROUPS AND SUBGROUPS OF THE GENUS.

On the basis of certain neanic characteristics the species of *Platystrophia* were found to be separable into three groups which Professor Cumings has called the *Uniplicate*, *Biplicate*, and *Triplicate* types.³

1. *Uniplicate group*.—In the uniplicate group the one plication in the sinus and two on the fold, at the end of the nepionic stage of development, continue unmodified throughout the entire life history, and there is no further modification of the fold and sinus except that both these parts and the plications which they bear become broader as they approach the frontal margin.

2. *Biplicate group*.—In the biplicate group the median plication of the sinus bifurcates while on the fold a plication is intercalated in a median position. Some members of this group do not show a further development and are regarded as a subgroup which the writer will later refer to as subgroup A.

In subgroup B the bifurcation of the plication in the sinus is soon followed by the intercalation of a plication in a median position while on the fold the median secondary plication bifurcates.

In subgroup C the bifurcation of the primary plication in the sinus is followed by the implantation of a plication on each of the lateral slopes while on the fold, the two primary plications bifurcate.

¹ Amer. Journ. Sci., ser. 4, vol. 42, 1895, pp. 51-56.

² Idem., vol. 15, 1903, p. 40.

³ Idem, p. 10.

In subgroup D a plication is intercalated in a median position in the sinus and a lateral plication is implanted on each of the slopes, while on the fold all the plications bifurcate.

3. *Triplicate group*.—The greater number of North American species belong to the triplicate group. In this group the primary plication remains unmodified throughout the life history. In the early neanic stage a plication is implanted on each slope of the sinus, the one on the right side appearing first. Contemporaneous with this development the two primary plications of the fold bifurcate and form four plications.

The triplicate group was found to be separable into three subgroups which the writer is designating, the low fold, the high fold, and the *Ponderosa* subgroups. The first two subgroups are alike in possessing a long hinge line relative to the height. By a comparison of the growth stages both are found to pass through a similar development in the nepionic and early neanic stages. In the low fold subgroup the low rounded fold persists throughout its development and the plications of the fold and sinus remain of nearly the same strength. The second subgroup in the late neanic stage develops a high compressed fold on which the lateral plications become weak and tend to disappear, giving the fold an angular appearance.

Some individuals and varieties belonging to species of the low fold subgroup have slightly elevated folds, on which the lateral plications are somewhat weakened. This may be an expression of an innate tendency of the race to develop a high fold which was somewhat realized when the organism was subjected to the proper environmental stimulation.

Those species and varieties which are characterized by large size are placed in the *Ponderosa* subgroup.

These large *Platystrophias* have been called *Platystrophia lynx* or *Platystrophia biforata*, according as they were interpreted by the investigator.

Platystrophia biforata has been discussed in the preceding pages and it has been shown that the term is of no specific value.

In 1830 Eichwald¹ described *Terebratula (Platystrophia) lynx* as follows: "Spirifer, cardine elongato, recto, vertice, utriusque valvae prominulo, utraque valva sulcata, stratis singulis transversis ex testae incremento exortes, numerosissimis margine dentato; media parte unius valvae prominula, quadrisulcata, alterius vero parte eadem exclavata, profunda."

Eichwald's specimen was from the drift and was not figured. The description is not specific enough to delineate a species and accordingly is of no value.

Several hundred specimens were before the writer and an endeavor was made to find some logical classification of them. There are

gibbous, subquadrate forms with the hinge about equaling the width; these represent the species described by Doctor Foerste as *Platystrophia ponderosa* and seem to be confined to the Bellevue. There are globose forms found in the Mount Auburn which Foerste has described as *Platystrophia ponderosa auburnensis*; and there is an unusually large transverse form confined to the Arnheim formation which the writer is describing as *Platystrophia ponderosa arnheimensis*. But there are innumerable variants which refuse to mark any definite horizon and before they can be of any use to stratigraphy further data are needed.

RELATION OF THE GROUPS.

As the uniplicate stage is common to all *Platystrophias*, it is evident that there was a uniplicate ancestor with three and four plications on the lateral slopes. The species most closely related to this ancestral form is *Platystrophia uniplicata*, new species, from the New York Lower Trenton. That this is not a retrograde from the triplicate group is shown by the fact that none of the many specimens associated with it showed a tendency toward loss of the lateral plications of the fold and sinus. There is a uniplicate species in the Lower Trenton of Europe, but this form is gibbous and has a more specialized fold and sinus.

Divergence from the uniplicate stock must have taken place in early Ordovician or Upper Cambrian time, as somewhat specialized members of the triplicate group are found in the Black River.

The biplicate group must have diverged at a very early stage in the development of the genus, as the modification of the plications of the fold and sinus takes place before the shell has reached a length of 1 mm.

Subgroup A shows the least differentiation, as the median plication has not appeared in the sinus, and the median plication of the fold has not bifurcated. It therefore stands closer to the ancestral stock than the other subgroups. Its occurrence with the *uniplicate group* and subgroup B does not necessarily mean that differentiation was taking place in Lower Trenton time, but rather that the *uniplicate type* and subgroup A were representatives of the primitive stocks which give rise to the other subgroups in early Ordovician time.

Subgroups B and C diverged from the radical represented by subgroup A about the same time; one added a plication in a median position in the sinus and the other added plications on the slopes. A very little later subgroup D diverged from C by adding plications on the lateral slopes.

As the triplicate group retains the uniplicate condition until the shell has reached a length of 1.2 to 1.5 mm., it must have diverged from the ancestral stock much later than the biplicate group.

All of the Trenton triplicate species except *Platystrophia preponderosa*, new species, belong to the low-fold subgroup, which preserved the low fold and convex form of the ancestral stock. Members of this group persisted into the Maysville, being represented by *Platystrophia juvenis*, new species; *Platystrophia panciplicata*; *Platystrophia strigosa*, new species; *Platystrophia nitida*, new species; *Platystrophia morrowensis*; *Platystrophia corryvillensis*, new species; and *Platystrophia sublaticosta*, new species. While there were seven species present, four of these were confined to the Lower Maysville and two are limited to narrow horizons in the Corryville. *Platystrophia sublaticosta*, new species, which ranges through the Fairmount, Corryville, and Mount Auburn, has only a scanty representation.

There is an increase in the number of low-fold species in the Richmond. Some of these are so similar to the Upper Trenton members of the genus as to require great care in differentiation. This is especially true of *Platystrophia foerstei*, new species, and *Platystrophia precursor latiformis*, new variety. The Richmond species is distinguished by its somewhat deeper sinus. *Platystrophia attenuatus*, new species, which occurs in the Waynesville at Waynesville, Ohio, has many characters in common with *Platystrophia amoena*, new species, of the Middle Trenton and *Platystrophia juvenis* of the Lower Maysville Group. The Richmond species usually has fewer plications on the lateral slopes. *Platystrophia moritura* of the Upper Richmond is distinguished from *Platystrophia precursor augusta*, new variety, of the Upper Trenton, with difficulty. In all these instances the Richmond species has a somewhat deeper sinus.

The writer is not inclined to regard this similarity of form as being due to reversion to primitive types. The Maysville species had undergone too many changes to leave no record in the ontogeny. It seems to indicate a reinvasion of the region by *Platystrophia*s from an area where environmental conditions during Lower and Middle Cincinnati time did not stimulate decided change. This recurrence agrees with Doctor Ulrich's observations on the recurrence of Cathey's corals. He says: "These same corals, or, rather, their scarcely distinguishable descendants, appear once more in the Richmond series of Ohio, Indiana, and Kentucky."¹

While many of the Richmond members are quite like those of earlier horizons, there are many whose physiognomy is entirely distinct. Such species as *Platystrophia annieana*, *Platystrophia clarksvillensis*, *Platystrophia cumingsi*, new species, and *Platystrophia acutilirata* are decidedly more transverse and their brachial valves are more ventricose than any of the earlier forms. They also tend to have a greater number of plications on the lateral slopes.

Extreme specialization was expressed in the low fold subgroup by the long hinge line and many plications on the lateral slopes. This

¹ Revision of the Paleozoic System, Bull. Geological Soc. America, vol. 22, 1911, no. 3, p. 300.

culmination is followed in the Upper Whitewater by loss of vitality, as is indicated in the excessive deposit of lime, narrowing of the shell, and loss of plications next to the cardinal angles.

The high-fold subgroup passes through an accelerated low-fold development, and in the late neanic stage develops a high compressed fold on which the plications are weak. It has no representatives in the Trenton. There are occasional individuals which have a somewhat higher fold than others, but this seems to represent only an attempt at the realization of a latent tendency which was never fully expressed.

Platystrophia pauciplicata is a *Platystrophia juvenis*, new species, which has lost two of the lateral plications on the lateral slopes. Variants from *Platystrophia pauciplicata* developed a high fold and merged into *Platystrophia profundosulcata* by all degrees of variants.

From some of these variants *Platystrophia crassa* developed. The most abundant mutation of this species has a globose form and high compressed fold and deep sinus, on which the plications are weak. In the mutation which James took as his type the lateral plications of the fold and sinus have disappeared or exist as rudimentary structures next to the beak. Another mutation has only four or five plications on the lateral slopes. These mutations indicate that this species was on the decline, having reached the highest point of specialization in the high fold mutation.

Platystrophia laticosta is a transverse species with a high compressed fold on which the plications are weak. The young of this species resemble *Platystrophia profundosulcata* but the fold is not so high nor the sinus so deep. Index curves and the physiognomy of the shell indicate that *Platystrophia laticosta* developed from one of the high fold variants of *Platystrophia pauciplicata*.¹

Platystrophia unicastata developed from *Platystrophia laticosta* by all degrees of variants. It marks the culmination of a development toward a high compressed fold on which the lateral plications have disappeared or exist as rudimentary structures next to the beak. But with this high specialization came extinction, as loss of vitality is indicated by the narrowing of the shell, increase in gibbosity, and loss of plications next to the cardinal angles. The variety *crassiformis* marks extreme racial gerontism, as there are only four or five plications on the lateral slopes and the form has become so narrow and gibbous that the thickness equals or is even greater than the width and height.

The physiognomy of *Platystrophia cypha* of the Arnheim formation suggests its development from *Platystrophia unicastata*, but this is not likely, as the latter species is taking on declining characteristics.

¹ Professor Cumings has demonstrated the origin of *Platystrophia crassa* and *Platystrophia laticosta* from *Platystrophia pauciplicata*. Amer. Journ. Sci., ser. 4, vol. 15, p. 23.

It marks a development toward a loss of plications on the lateral slopes, while *Platystrophia cypha* marks the culmination of a development toward an increase in the length of the hinge line and in the number of plications on the lateral slopes. This is accompanied by the development of a high compressed fold and profound sinus on which the lateral plications have disappeared or exist only as rudimentary structures. These characteristics represent the highest degree of specialization reached by the high fold subgroup. The culmination is followed by decline, which is indicated by the development of a galaxy of variants. Those variants, which are tied together by a group of constant characteristics, are described in the following pages as varieties of this species but by far the greater number will permit of no classification.

In the Lower Maysville members of this subgroup were rare. However, from late Fairmount until the end of the Maysville, they form the most conspicuous fossil, being represented by great numbers of *Platystrophia crassa* in the Upper Fairmount, *Platystrophia laticosta*, and *Platystrophia unicosata* in the Bellevue and Corryville and Mount Auburn. At the end of the Maysville most of these species became extinct. *Platystrophia cypha*, however, lived into the Arnheim and became associated with the members of the low fold subgroup, which had migrated into the area.

From a study of the early development of members of the *Ponderosa* subgroup the conclusion was reached that these specimens represent degenerate branches of the genus which originated while the race was still in a progressive state of development.

Platystrophia preponderosa, new species, of the Upper Trenton group, passes through a *Platystrophia precursor* development and then becomes globose. There existed during the Maysville and lower Richmond time a large form with a long hinge line and equi-convex valves, and low spreading fold. The early development of these is almost identical with that of *Platystrophia precursor*. Most of these large *Platystrophias* are globose with the brachial valve much the deeper, and with moderately elevated folds.

The writer's investigation revealed very little as to the origin of this protean group. All of them, however, pass through a low-old development which indicates their origin from some member of that subgroup. It may be that various members possessed the possibility of large size which was realized in one or more lines. When their energy was exhausted, decline was marked by assumption of gerontic characters and the development of multitudinous forms which are so diverse as to permit of little classification.

PARALLELISM IN DEVELOPMENT.

This genus furnishes several examples of convergence in development. The adult members of the most specialized mutations of

Platystrophia crassa and *Platystrophia unicostata crassiformis*, new variety, are narrow globose forms with high-compressed folds and deep sinuses on which the lateral plications are weak or have disappeared. The growth stages and the many variants show that the former is derived from *Platystrophia paniculata* while the latter is derived from the *laticosta* stock.

Typical specimens of the adult *Platystrophia unicostata* of the Maysville group find their almost exact equivalent in adult specimens of *Platystrophia cypha bellatula*, new variety, of the middle Richmond, although the Maysville form originated from *Platystrophia laticosta* and the Richmond form from *Platystrophia cypha*.

A comparison of the biplicate and triplicate groups furnishes a good example of parallel development. Belonging to both are retrograde globose species. There are transverse species with high-compressed folds and deep sinuses on which the plications are rudimentary or absent. There are species in both groups with extremely long hinge lines and many plications on the lateral slopes, and there are large ponderosa-like forms.

This seems to indicate that the ancestral species had certain latent possibilities, and though divergence took place early, these possibilities were transmitted to the various groups and subgroups and were expressed in a definite order whenever the appropriate environmental stimulation was present.

PHYLOGERONTIC TYPES.

Platystrophia rhynchonelliiformis, new species, of the Lower Trenton; *Platystrophia amoena robusta*, new variety, of the Middle Trenton; and *Platystrophia globossa*, new species, and *Platystrophia preponderosa*, new species, of the Upper Trenton are globose forms which show a tendency to loss of plications next to the cardinal angles. They are phylogerontic members of the genus which have developed while the race was still young.

The *Ponderosa* subgroup, which is abundantly represented in the Maysville group of Indiana, Ohio, and Kentucky, seems to represent the phylogerontic end members of lines from the low fold subgroup, which soon exhausted their energy in assuming large size. Professor Cumings has called it a veritable race of gerontic individuals. The greater number of them have the thickness equalling or exceeding the width and there is obsolescence of plications next to the cardinal angles. An excessive deposit of lime occurs in all of them. These characters point to loss of vigor and mark a return to second childhood.

Another example of phylogerontism is found in *Platystrophia crassa*. *Platystrophia crassa* passes through a long-hinged development and in the late neanic stage takes on gerontic characteristics. The globose tendency becomes so pronounced in this species that the thickness equals or exceeds the height in the adult. Increase in

thickness is accompanied by weakening or loss of the lateral plications of the fold and sinus and those of the lateral slopes next to the cardinal angles.

The globose variety, *Platystrophia unicostata crassiformis* represents a phylogerontic development from *Platystrophia laticosta* through *Platystrophia unicostata*, and the many narrow paniculate variants of *Platystrophia cypha* represent a like development from that species.

In *Platystrophia acutilirata* the shell is so thickened centrally and anteriorly that the space occupied by the soft parts is exceedingly small when compared to the size of the shell. This indicates that this species is the most gerontic of the genus. Both valves are marked by strong growth varices, which in the less specialized forms turn out toward the cardinal extremities.

PATHOLOGIC INDIVIDUALS.

In the Arnheim beds of the Ohio Valley pathologic individuals belonging to the *Ponderosa* subgroup are quite common. They are large, globose, asymmetrical forms frequently with distorted beaks. There is a tendency toward the loss of the fold on one side in some individuals. In others there is a loss of lateral plications of the fold and sinus, and again the plications of the lateral slopes encroach on the fold and sinus in late neanic or ephebic development. This may be accompanied by loss of plications on the lateral slopes next to the cardinal angles, or this development may take place independently.

RECURRENT MUTATIONS.

Typical specimens of the triplicate group have three plications in the sinus and four on the fold. In nearly every species and variety of the triplicate group there are individuals in which there are a greater number. The plications are added in various positions, but, with two apparent exceptions, they originate by implantation in the sinus and bifurcation on the fold. The addition of plications on the fold follows the same order of appearance as occurs in the sinus.

Hugo de Vries has shown that some flowers regularly produce certain mutations with characteristics which do not become fixed. He says:

Such deviations are usually called sports. But they occur yearly and regularly and may be observed when the cultures are large enough. Such a variety I shall call "ever-sporting."

The striped larkspur is one of the oldest garden varieties. It has kept its capacity of sporting through centuries, and therefore may in some sense be said to be quite stable. Its changes are limited to a rather narrow circle and this circle is as constant as the peculiarities of any other constant species or variety. But within this circle it is always changing from small stripes to broad streaks and from them to pure colors. * * * Combining the stability and the qualities of sports in one word, we may evidently best express it by the new term of ever-sporting variety.¹

¹ Species and Varieties. Their Origin by Mutation, p. 311.

It seems to the writer that the species of *Platystrophia* represent the "ever-sporting varieties" of De Vries, and the different mutations are marked by variation in the plication pattern. The propagation of these mutations is most prominent in the Low Fold and *Ponderosa* subgroups and rare in the High Fold subgroup.

This development is so pronounced in *Platystrophia elegantula*, new species, that it has become of specific value. *Platystrophia narrowensis* also shows a prolific development of these individuals.

ORTHOGENESIS.

In order to simplify the discussion of the life history it is thought advisable to construct first a diagram as a guide to the discussion which will follow. The purpose of the diagram is to illustrate the common characters of the various groups and subgroups into which the genus can be subdivided and the common order of appearance of these characters. The line represents the ontogeny and it is subdivided into the ontogenetic stages which are indicated by letters. The early onto stages are so condensed as to make it impossible to measure with accuracy their relative duration, but an effort is made to indicate where a developmental stage is noticeably shorter in one group than in another.

Uniplicate Group.	Primitive ancestor.....	A	B	C
	P. uniplicata.....	A B	C	D.
	Specialized members.....	A B	C D	F I
Biplicate Group.	Subgroup A.....	A B	C D	E
	Specialized members.....	A B	C D	E F I
	Subgroup B.....	A B	C D	E E ¹
	Specialized members.....	A B	C D	E E ¹ F I
	Subgroup C.....	A B	C D	E E ²
	Specialized members.....	A B	C D	E E ² F I
	Subgroup D.....	A B	C D	E E ¹ E ²
Specialized members.....	A B	C D	E E ¹ E ² F I	
Triplicate Group.	Low Fold subgroup.....	A B	C D	E ²
	Ponderosa subgroup.....	A B	C D	E ² F H I
	High Fold subgroup.....	A B	C D	E ² G F I

MORPHIC STAGES.

- A. Smooth protegulum stage.
- B. Ribbed stage.
- C. True ventral sinus and brachial fold developed.
- D. Plications added on lateral slopes.
- E. Plication in sinus bifurcates and plication intercalated in a median position on fold.
- E¹. Plication intercalated in a median position in the sinus and median plication on the fold bifurcates.
- E². Plication implanted on each slope of sinus and primary plication of fold bifurcates.
- F. Increase in size.
- G. Elevation of fold.
- H. Excessive increase in size.
- I. Specialized and individual characters.

An examination of the diagram shows that all *Platystrophias* pass through stages A, B, C, and it is inferred that these stages represent the entire life history of a primitive ancestor which lived in late Cambrian or early Ordovician time. The uniplicate group adds stage D, and the more specialized species of the group add stages F and I. Subgroup A recapitulates the development of the unspecialized members of the uniplicate group and adds stage E, and the more specialized species add stages F and I. Subgroup B recapitulates the ontogeny of the unspecialized members of subgroup A and adds stage E¹ and the more specialized species add F and I. Subgroup C recapitulates the ontogeny of the unspecialized members of subgroup A, and adds stage E² and the more specialized members add F and I. Subgroup D recapitulates the ontogeny of the unspecialized members of subgroup B and adds stage E² and the specialized species add stages F and I.

The low-fold subgroup recapitulates the ontogeny of the unspecialized members of the uniplicate group and adds stage E² and the more specialized species adds stages F and I. The *Ponderosa* subgroup recapitulates the ontogeny of the low-fold subgroup and adds stage H, and the high-fold subgroup recapitulates the ontogeny of the low-fold subgroup and adds stage E.

CORRELATION OF THE PHYLOGENY AND STRATIGRAPHIC SUCCESSION.

This progressive development is in harmony with the stratigraphic succession of the species representing the groups and subgroups.

According to our present knowledge species of this genus appeared in North America and Europe in early Middle Ordovician time. The earliest North American form is found in the Black River group (Decorah Shale) 4½ miles north of Fennemore, Tennessee. This form has been referred to *Platystrophia extensa*, new species, and belongs to the triplicate group. As the long hinge and broad lateral slopes bearing numerous plications indicate a certain degree of specialization it is evident that the genus was in existence prior to this time.

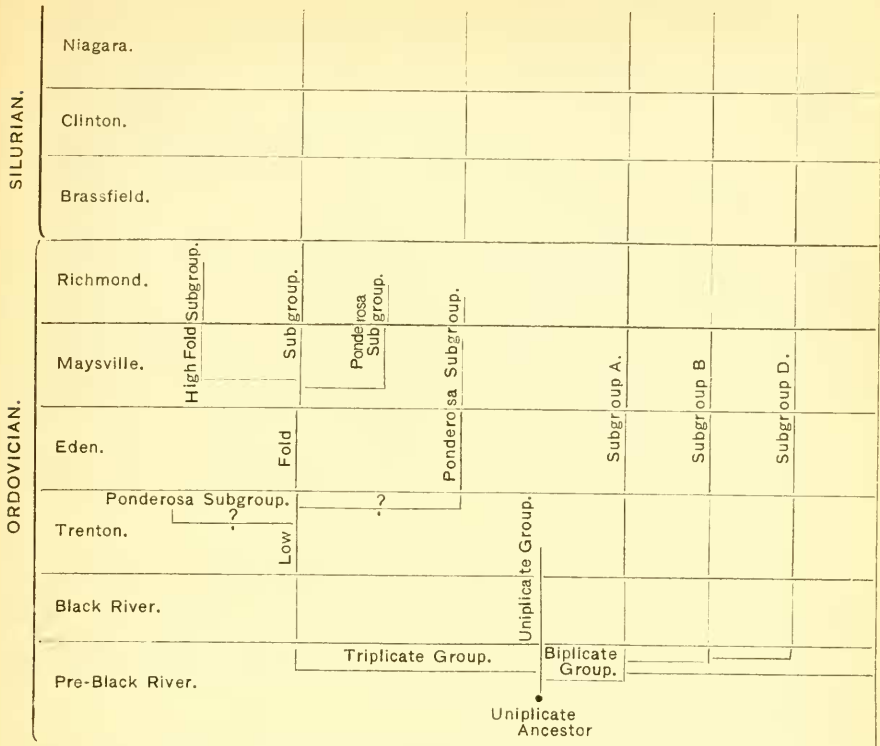
Hall and Clarke¹ have reported a form from the Chazy. Winchell and Schuchert say,² "This widely distributed and protean species has its beginning in North America in the Chazy group and is found in all geological horizons upward and into the Niagara formation." Schuchert³ and Ruedemann⁴ have also reported occurrence of species in the Chazy.

¹ Paleontology of New York, vol. 8, pt. 1, Brachiopoda, 1892, p. 202.

² Geol. of Minnesota, vol. 3, pt. 1, Paleontology, 1892, p. 456.

³ Synopsis of American Fossil Brachiopoda, 1897, p. 309.

⁴ Bull. N. Y. State Museum, No. 49, 1891, 1902, p. 25.



In the extensive collections belonging to the United States National Museum no members of this genus were found below the Black River Group. Professor Cumings investigated this point and reached the same conclusions. He says: ¹

I am unable to find any original references in the literature to its occurrence in the rocks of this age (Chazy). Messrs. Ami, Whiteaves, and W. Billings of Ottawa, Canada, inform me that the Museum of the Canadian Survey contains no Chazy specimens; and that they are not aware that the species has ever been found in that series. Mr. Billings suggests that it may have been found in rocks formerly held as Chazy, but now known to be of later age. Mr. McBride, of Montreal, writes that there are no Chazy specimens in the Museums at Montreal and that he does not know of the occurrence of *Platystrophia* in the Chazy. Mr. Seely, who is familiar with the Chazy, writes to the same effect. It is very probable, therefore, that the form is not known to occur below the Trenton in this country.

While our knowledge does not substantiate the occurrence of this genus below the Decorah Shale, the degree of variation which it has reached by that time leads the writer to expect that earlier species will come to light with more extended investigation.

The Black River and early Trenton species show but little variation in general physiognomy. The shells are equiconvex and have

¹ Amer. Journ. Sci., ser. 4, vol. 15, 1903, p. 5.

low spreading folds and shallow sinuses. The genus had expressed its invariability in Cambrian or early Ordovician time by differentiation of the plication pattern of the fold and sinus. This differentiation was at that time only of specific value. These species, however, became the source of lines of development which persisted until the extinction of the race. Thus, while near the origin of the genus differentiation was not pronounced, the variation which achieved expression was of high taxonomic value.

The uniplicate group is confined to the Lower Trenton of North America and seems to occupy that horizon in Europe, where it is associated with members of the biplicate and triplicate groups.

In North America the biplicate group is not found in the Ordovician above the Lower Trenton except in the Uppermost Richmond of Anticosti Island. Its recurrence in North American early Silurian points to its existence during Middle and Upper Trenton and Cincinnati time in an area which was cut off from North American seas.

The writer had access to about 200 specimens from the Baltic province of Europe. These range in age from Lower Middle Ordovician (Kuckers) into the Silurian. A uniplicate species was found to occur in the Jewe, and one specimen was found which occurred in the Upper Ordovician (F¹). All the other species belonged to the biplicate group.

The inaccessibility of the literature made it impossible for the writer to determine the limits of the European species and the group to which they belong. The figures and descriptions by Davidson and other authors help but little. Davidson's figures 15*a*, 17, 18, 19¹ represent specimens of the biplicate type from the Caradoc. The Wenlock species (figs. 11, 11*a*) are also of the biplicate type and seem to be related to *Platystrophia regularis* Shaler. The abundance of this group throughout European Ordovician and its limitation to the Lower Trenton and early Silurian of North America suggest an invasion from that area which was followed by extinction of the invading forms.

The Trenton members of the triplicate group belong to the low-fold subgroup which is most closely related to the ancestral stock. Members of this subgroup persisted into the Maysville, but by the end of that time they became rare. A reincursion in Richmond time brought in several species belonging to the low-fold subgroup which are scarcely distinguishable from Trenton forms. Extreme specialization and extinction was reached in late Cincinnati and early Silurian time.

The high-fold subgroup originated in early Maysville. It became the predominant type in Middle Maysville to Middle Richmond

¹ British Fossil Brachiopoda, vol. 1, pl. 28.

time and marks the acme of specialization which was reached by the genus.

The *Ponderosa* subgroup which is conspicuous in Maysville and Lower Richmond time represents members of the genus which expended their energy in acquiring large size and then became prematurely old while the race as a whole was progressive.

The writer was unable to determine the relative abundance and stratigraphic succession of European members of the genus.

Davidson's figures, 12, 13, and 25¹ are distinctly of the triplicate type, and seem to be related to *Platystrophia colbeinsis* Foerste. Figure 14¹ evidently marks a retrograde form of this species as is indicated by the one plication in the sinus.

¹ British Fossil Brachiopoda, vol. 1, pl. 38.

<i>Platystrophia rhyncbouella</i> Formis, new species.....																				
<i>Platystrophia cobbiensis</i> Foerste.....																				
<i>Platystrophia cobbiensis madata</i> Foerste.....	X																			
<i>Platystrophia precursor</i> Foerste.....		X																		
<i>Platystrophia precursor latiformis</i> , new variety.....			X																	
<i>Platystrophia precursor angustata</i> , new variety.....				X																
<i>Platystrophia juvenis</i> , new species.....																				
<i>Platystrophia pauciplicata</i> Cummings.....					X															
<i>Platystrophia strigosa</i> , new species.....					X															
<i>Platystrophia nitida</i> , new species.....					X															
<i>Platystrophia morrowensis</i> (James).....						X														
<i>Platystrophia corryvillensis</i> , new species.....							X													
<i>Platystrophia sublatirosta</i> , new species.....								X												
<i>Platystrophia acuminata</i> (James).....							X													
<i>Platystrophia foerstei</i> , new species.....							X													
<i>Platystrophia foerstei ampla</i> , new variety.....								X												
<i>Platystrophia attenuata</i> , new species.....									X											
<i>Platystrophia clarksittensis</i> Foerste.....										X										
<i>Platystrophia cumingi</i> , new species.....											X									
<i>Platystrophia anakana</i> Foerste.....												X								
<i>Platystrophia mortura</i> Cummings.....													X							
<i>Platystrophia acutitirata</i> (Conrad).....														X						
<i>Platystrophia acutitirata prolongata</i> Foerste.....															X					
<i>Platystrophia senec</i> Cummings.....																X				
<i>Platystrophia elkhornensis</i> , new species.....																	X			
<i>Platystrophia preponderosa</i> , new species.....																		X		
<i>Platystrophia ponderosa</i> Foerste.....																				
<i>Platystrophia ponderosa auburnensis</i> Foerste.....																				
<i>Platystrophia ponderosa arnhemensis</i> , new variety.....																				
<i>Platystrophia ponderosa</i> , varieties undescribed.....																				
<i>Platystrophia crinalensis</i> , new species.....																				
<i>Platystrophia profundosulcata</i> (Meek).....																				
<i>Platystrophia profundosulcata honpenis</i> Foerste.....																				
<i>Platystrophia crassa</i> (James).....																				
<i>Platystrophia crassa</i> ? variety undescribed.....																				

Low fold.

Ponderosa.

High fold.

Triple.

DESCRIPTION OF SPECIES.

1. UNIPLICATE GROUP.

PLATYSTROPHIA UNIPLICATA, new species.

Plate 42, figs. 1, 2.

Two specimens of a uniplicate *Platystrophia* were found in the Trenton of Lake Champlain. They are small and have low rounded folds on which are two plications which appear to originate in a point at the beak and extend to the frontal margin with a deep widening furrow between them. The shallow sinus is occupied by one median plication which originates at the beak and extends to the frontal margin. The lateral slopes are occupied by nine plications.

Measurements.—8.2 mm. along the hinge line, 12 mm. wide across the middle, 9 mm. high, 7 mm. thick, 5.5 mm. sinal width, 3 mm. sinal depth, 1 mm. fold depth.

Occurrence.—Trenton limestone near Lake Champlain, New York.

Holotype.—Cat. No. 66109, U.S.N.M.

2. BIPLICATE GROUP.

a. SUBGROUP A.

PLATYSTROPHIA PRECEDENS, new species.

Plate 42, figs. 7, 8.

A form occurring in relatively small numbers seems to represent an intermediate development between the uniplicate group and subgroup B of the biplicate group.

It has three plications on the fold, two of which are primary and appear to originate in a point at the beak, and one of which is a secondary plication intercalated in a median position; while in the sinus there are two secondary plications which have originated by the bifurcation of the primary plication at the beak.

It differs from *Platystrophia trentonensis*, new species, in that the median plication on the fold has not bifurcated, and in the absence of the median intercalated plication in the sinus.

Occurrence.—Trenton limestone, Lake Champlain, New York. Curdsville limestone of the Trenton group, Mercer County, Ky.

Cotypes.—Cat. Nos. 66111, 66112, U.S.N.M.

PLATYSTROPHIA REGULARIS Shaler.

Plate 42, figs. 21, 22.

Platystrophia regularis SHALER, Bull. Mus. Comp. Zool., vol. 4, 1865, p. 67.

Shaler's original description is as follows:

Outline much the same as that of other members of the group. Socket valve one-fourth more projecting than toothed valve; hinge line a little less than diameter of shell, three-fifths greater than distance from beak to border. That portion of the margin

occupied by the fold and sinus is reentering, the depth of the incurvation being about equal to the elevation of the umbo above the hinge line. The depressions of the sinus is occupied by only two plications and the ridge by three similar folds. On either side are from eight to nine plications. The numbers seem invariable.

The muscular area of the toothed valve is long and narrow, length being three or four times the width, extending nearly to the center of the valve—a feature in which this species differs from its representatives.

Occurrence.—Gamachen (Ellis Bay) and Anticostian (Gun River) Junction Cliff, etc., Anticosta.

Plesiotype.—No. 66108, U.S.N.M.

PLATYSTROPHIA DAYTONENSIS (Foerste).

Plate 42, fig. 24.

Orthis biforata var. *lynx forma daytonensis* FOERSTE, Bull. Sci. Lab., Denison Univ., 1, 1885, p. 81, pl. 13, figs. 1-8.

Orthis (Platystrophia) biforata (part) FOERSTE, Geol. Surv. Ohio, vol. 7, 1895, p. 579, pl. 25, fig. 8.

Platystrophia daytonensis SAVAGE, Bull. Geol. Surv. Illinois, vol. 23, 1913, p. 76, pl. 4, fig. 8.

The shell is small, wider than long with a subquadrate outline. The hinge line about equals the width across the middle. The fold bears three plications. Two originate in a point at the beak, the third is intercalated in a median position when the shell is about 1 mm. long. There are two plications in the sinus. As the posterior portion of the pedicle valve of the one specimen was broken away nothing definite can be said as to their origin, but it is inferred from other specimens which have a like plication pattern on the fold, that the two originate by the bifurcation of a primary plication at the beak. The lateral slopes are occupied by nine roundish plications which are separated by their own width.

Measurements.—18.5 mm. along the hinge line, 18.5 mm. wide across the middle, 14.2 mm. high, 13 mm. thick, 8 mm. sinal width, 6.7 mm. sinal depth, 2.5 fold depth.

Occurrence.—Brassfield formation, Dayton, Ohio; Hanover, Indiana; Cumberland Gap, Tennessee; Collinsville, Alabama; Nelson County, Kentucky. Edgewood formation; Edgewood and Louisiana, Missouri; Theber, Illinois.

Plesiotypes.—Cat. No. 66114, U.S.N.M.

PLATYSTROPHIA DAYTONENSIS LAURELENSIS, new variety.

Plate 42, figs. 42, 43.

This variety is distinguished from the Brassfield specimens by its smaller size and narrower form.

Measurements.—13 mm. along the hinge line, 14 mm. wide across the middle, 12 mm. high, 11 mm. thick (estimated), 18 mm. sinal width, 5 mm. sinal depth, 2 mm. fold height.

Occurrence.—Niagara group: Laurel limestone, St. Paul and Heatons Branch, East of St. Omar, Indiana.

Cotypes.—Cat. No. 66116, U.S.N.M.

b. SUBGROUP B—TRENTON SPECIES.

PLATYSTROPHIA TRENTONENSIS, new species.

Plate 42, figs. 3-6.

Platystrophia biforata GRABAU and SHIMER, North American Index Fossils, vol. 1, 1903, p. 258.—CUMINGS (part), Amer. Journ. Sci., ser. 4, vol. 15, 1903, p. 41.

In the Trenton limestone occurs a long hinged form which has the plication pattern of the Biplicate group. The hinge line is equal to or greater than the width across the middle. The fold is scarcely elevated above the convexity of the brachial valve, and it bears four plications of equal strength. The sinus of the pedicle valve is moderately deep and bears three plications of equal strength. There are twelve to fifteen plications on the lateral slopes.

This species has some resemblance to *Platystrophia amoena longicardinalis*, new variety, but the latter species belongs to the triplicate group.

Measurements.—16.7 mm. along the hinge line, 16 mm. across the middle, 12.3 mm. high, 11 mm. thick, 7.4 mm. sinal width, 4.7 mm. sinal depth, 0.7 mm. fold height.

Occurrence.—Trenton group. Prosser limestone at Fountain and Montorville, Minnesota, and at Decorah, Iowa. Curdsville limestone at Troy, Kentucky. Trenton limestone at St. Joseph Island, Lake Huron.

Cotypes.—Cat. Nos. 39052, 66097, U.S.N.M.

PLATYSTROPHIA TRENTONENSIS CHAMPLAINENSIS, new variety.

Plate 42, figs. 9-11.

Platystrophia biforata CUMINGS (part), Amer. Journ. Sci., ser. 4, vol. 15, 1903, p. 41.

In the Trenton limestone of Lake Champlain is a small form which resembles *Platystrophia elegantula*, new species in the shape of the shell but the forms are easily distinguished by their plication patterns.

This variety differs from typical specimens of the species in possessing a much shorter hinge-line and in a tendency toward obsolescence of plications next to the cardinal angles.

Occurrence.—Trenton limestone, near Lake Champlain, New York.

Holotype.—Cat. No. 66099, U.S.N.M.

PLATYSTROPHIA TRENTONENSIS PERPLANA, new variety.

Plate 42, figs. 12-14.

Platystrophia biforata WELLER, Pal. New Jersey, vol. 3, 1903, p. 153, pl. 9, figs. 25-28.

This variety is distinguished from other members of the species by its greater width and height and thinner form. The fold is

broad and low and the sinus broad and shallow. Nine plications occupy the lateral slopes. The hinge line generally equals the width across the middle, but it may be somewhat less than the width.

Measurements.—18 mm. along the hinge line, 18.5 mm. wide across the middle, 12.5 mm. high, 8.5 mm. thick, 10 mm. sinal width, 2.5 mm. fold height.

Occurrence.—Trenton group. Curdsville limestone: Mercer County, Shyrock's Ferry and Bergen, Kentucky; and Crossville Quadrangle, Tennessee. Prosser limestone at Fountain, Minnesota; Jacksonburg limestone, New Jersey.

Cotypes.—Cat. Nos. 66093, 66095, U.S.N.M.

c. SUBGROUP C.

PLATYSTROPHIA BRACHYNOTA (Hall).

Plate 42, figs. 25–28.

Delthyris brachynota HALL, Geol. New York, Rept. 4th Dist., 1843, p. 70, fig. 6.

Orthis biforata NETTELROTH, Kentucky, Foss. Shells, 1889, p. 35, pl. 29, figs. 18–22.

Spirifer biforatus var. *lynx* HALL, Pal. New York, vol. 2, 1852, pl. 22, fig. 1.

Orthis lynx CHAPMAN, Canadian Journ., new ser., vol. 8, 1863, p. 199, fig. 185.

This species is about the size of *Platystrophia daytonensis*, but it always has a shorter hinge line and a greater number of plications on the fold and sinus. After the one plication in the sinus has bifurcated a lateral plication is added on each of the sinal slopes, while on the fold, the intercalation of the median plication is followed by the bifurcation of the primary plications. Seven and eight plications occupy the lateral slopes.

Measurements.—17.3 mm. along the hinge; 20.4 mm. wide across the middle; 14.5 mm. high; 11 mm. sinal width; 6 mm. sinal depth; 3.5 mm. fold height.

Occurrence.—Clinton group of New York. Brassfield limestone, Nelson County, Kentucky. Niagara Group. Reynolds Basin, Niagara County, New York. Louisville limestone, Louisville, Kentucky.

Plesiotypes.—Cat. Nos. 39046, 51348, U.S.N.M.

PLATYSTROPHIA REVERSATA (Foerste).

Plate 42, fig. 23.

Platystrophia biforata var. *lynx* forma *reversata* FOERSTE, Bull. Sci. Lab. Denison Univ., vol. 1, 1885, p. 81, pl. 13, fig. 7.

Orthis (Platystrophia) biforata (part) FOERSTE, Pal. Ohio, vol. 7, 1895, p. 579, pl. 25, fig. 8.

This was described by Foerste as follows:

Shell attaining a fair size, the dorsal valve a little larger; shell wider than long, with a subquadrate outline; no very gibbous forms have as yet been found; hinge line less than the greatest breadth of the valves; cardinal extremities obtusely angular; lateral margins rather sinuous near the hinge-line, rounding to the front, where it is

somewhat sinuously rounded at the junction of the mesial sinus and fold. Beaks nearly equal, incurved and approximate, sometimes almost touching; cardinal areas nearly equal.

Dorsal valve more convex than the ventral, its greatest convexity being near the middle. Mesial fold rather rounded, arising near the beak, becoming more prominent as it extends forward, with rounded sides; beak projecting beyond the hinge margin, strongly incurved; cardinal area directed backward, somewhat incurved; foramen broad, triangular and not closed by the cardinal process.

Ventral valve of a mesial sinus, beginning near the beak, extending forward, terminating in a rounded projection which continues the curvature of the shell and thus produces a sinuous outline for the front edge of the shell. Surface of the valve rounded into the moderately concave sinus. Beak less strongly incurved than that of the dorsal valve. Cardinal area incurved and directed backward, less, however, than that of the other valve. Foramen triangular, wider than high; hinge teeth moderately prominent and trigonal; muscular cavity oblong, little more than one third the length of the shell, lateral margins parallel, well defined by the dental ridges. On either side of this cavity are a number of short striae, which are arranged in longitudinal lines following about the direction of the plications.

Surface of each valve with rounded, radiating plications, from 24 to 36 in number, of which 4 to 6 occupy the mesial sinus, and 5 to 7 (in one specimen 10 or 11) the mesial fold. In the sinus two plications begin at the beak, two additional ones are immediately added, and later one or two more at one-third or one-half the length of the shell from the beak. On the mesial fold three plications originate at the beak, to which two more are added at one-fourth the length of the shell from the beak; later two more appear and in one specimen in hand 10 or 11 plications are more or less distinctly shown. The plications in the sinus and on the fold branch in all specimens as described above; the lateral ones, 10 to 15 in number, are almost always simple. Lines of growth not shown in the specimens found. Well preserved specimens under the microscope show numerous minute granules, arranged in regular rows across the plications.

Occurrence.—Brassfield limestone; Dayton, Ohio.

Plesiotype.—Cat. No. 48626 U.S.N.M.

d. SUBGROUP D.

PLATYSTROPHIA HERMITAGENSIS, new species.

Plate 42, figs. 15-19.

This represents a species, the types of which were collected from the Hermitage limestone of Auburn, Tennessee. It is a thin, long-hinged form with subequally convex valves. The species resembles *Platystrophia extensa*, new species, in general physiognomy, but the latter belongs to the Triplicate Group.

In the nepionic stage there is one plication in the sinus and two on the fold which appear to originate in a point at the beak. The neanic stage is initiated by the bifurcation of the plication in the sinus and on the fold this development is marked by the intercalation of a median secondary plication. After a slight interval of growth a plication is intercalated in a median position in the sinus, and a little later a plication is implanted on each of the sinal slopes, while on the fold first the median plications and then the primary plications bifurcate.

Some specimens do not show a further development but the greater number show that the median plication in the sinus has bifurcated and a seventh plication is intercalated on the fold in a median position.

There are 9 to 13 somewhat round plications on the lateral slopes. The slopes of the pedicle valve are almost flat or slightly concave; those of the brachial valve are slightly convex. The fold is low and broad and the sinus is shallow. The characteristic granular markings of the surface are unusually distinct.

Measurements.—27.4 mm. along the hinge, 24 mm. wide across the middle, 14.4 mm. high, 10 mm. thick, 9 mm. sinal width, 4.2 mm. sinal depth, 1.2 mm. fold height.

Occurrence.—Trenton group. Hermitage limestone; Payton's Creek, 6 miles northwest of Carthage, and Auburn, Tennessee.

Cotypes.—Cat. Nos. 66100, 66101, U.S.N.M.

3. TRIPPLICATE GROUP.

a. LOW FOLD SUBGROUP.

PLATYSTROPHIA EXTENSA, new species.

Plate 42, figs. 39-41.

Associated with *Platystrophia hermitagensis* is a species with the same general physiognomy. Its distinguishing characteristic is the plication pattern of the fold and sinus which places it with the *Triplicate group*.

The hinge line varies from nearly as great to greater than the width of the shell across the middle. The valves are subequally convex. The slopes of the brachial valve are flattish, with a tendency to become concave; those of the pedicle valve are convex. There are 9 to 13 round plications on the lateral slopes, which are separated by furrows of their own width.

Two specimens were found in the Decorah shale near Fennimore, Tennessee, which are referred to this species. However, they have proportionally longer hinge lines and more ventricose forms than the Trenton specimens.

A specimen measures 21 mm. along the hinge, 20.5 mm. wide across the middle, 12 mm. high, 8.8 mm. thick, 7.5 mm. sinal width, 2.7 mm. sinal depth, 1 mm. fold height.

Occurrence.—Trenton group: Hermitage limestone at Hartsville and Auburn, Tennessee. Black River group: Decorah shale 4½ miles north of Fennimore, Wisconsin.

Cotypes.—Cat. Nos. 66102, 66103, U.S.N.M.

PLATYSTROPHIA ELEGANTULA, new species.

Plate 43, figs. 44-47.

The types of this species were found in the Bigby limestone of the Trenton group at Frankfort, Kentucky, and vicinity. It is common

at various localities in Kentucky and Tennessee and was found to be present in New York.

The species is characterized by its small size and subglobose form. The hinge line is always less than the greatest width. The slopes are convex and are covered by nine fine rounded plications which are separated by furrows of their own width. The fold is low and the sinus shallow. Both the fold and sinus become progressively wider toward the front.

Near the beak there are three plications in the sinus and four on the fold. When the shell has reached a length of about 6 mm., plications are added by implantation in the sinus and bifurcation on the fold, sometimes between the original plications and sometimes on the slopes.

This species differs from *Platystrophia amoena*, new species, in its shorter hinge and in that there are, as a rule, more than three plications in the sinus and four on the fold. The latter species shows a tendency toward the loss of plications rather than the addition of them.

All species of *Platystrophia* show a tendency to produce mutations which develop many plications on the fold and sinus. This species seems to have developed from one of these mutations.

Occurrence.—Trenton group: Bigby limestone at Frankfort, Kentucky, and vicinity, and Hartsville, Tennessee. Trenton group at Ellisburg, New York.

Cotypes.—Cat. No. 24244, U.S.N.M.

PLATYSTROPHIA ELEGANTULA TRIPLICATA, new variety.

Plate 43, fig. 48.

Platystrophia lynx CUMINGS, Amer. Journ. Sci., ser. 4, vol. 15, 1903, p. 41.

This variety has all the characteristics of the types except that there are only three plications in the sinus and four on the fold. It resembles the shorter hinged mutations of *Platystrophia amoena*, new species, and may prove to be a variety of that species.

Occurrence.—Trenton group: Bigby limestone, Duckers and Frankfort, Kentucky; Nashville, Tennessee. Trenton limestone, Ellisburg and Trenton Falls, New York, and in Baffin Land.

Holotype.—Cat. No. 66126, U.S.N.M.

PLATYSTROPHIA ELEGANTULA AMPLISULCATA, new variety.

Plate 43, fig. 49.

This represents a variety of *Platystrophia elegantula* with a decidedly shorter hinge line than typical specimens and a broader fold and sinus which bear more numerous plications.

Measurements.—11.2 mm. along the hinge, 18.5 mm. wide across the middle, 13.5 mm. high, 12.3 mm. thick, 10 mm. sinal width, and 6.8 mm. sinal depth.

Occurrence.—Trenton group: Bigby limestone, Frankfort, Kentucky. Trenton limestone, Ellisburg, New York.

Cotypes.—Cat. No. 66124, U.S.N.M.

PLATYSTROPHIA AMOENA, new species.

Plate 43, figs. 1-8.

Platystrophia lynx CUMINGS, Amer. Journ. Sci., ser. 4, vol. 15, 1903, pp. 20, 22, 24, figs. 8, 10.

Orthis biforata HALL and CLARKE, Pal. New York, vol. 8, pt. 1, 1892, pl. 5B, fig. 10.

This is a thin transverse species with subequally convex valves. The hinge line is as long or nearly as long as the width across the middle. The fold is low and spreading and the sinus is shallow. The fold is occupied by four and the sinus by three plications. There are nine plications on the lateral slopes.

This species resembles *Platystrophia elegantula*, new species, but it lacks the curved plications on the lateral slopes, and it has a longer hinge line than that species. A much thicker variety is found at various localities associated with typical specimens. The thickness may become as great as or greater than the height. Shells of this type are abundant at Trenton Falls, New York, and for these the name *Platystrophia amoena robusta* (pl. 43, figs. 14-17, Cat. No. 66091, U.S.N.M.) is suggested.

Measurements.—13 mm. along the hinge line, 14 mm. wide across the middle, 10 mm. high, 6.3 mm. thick, 5.5 mm. sinal width, 2 mm. sinal depth, 0.7 mm. fold depth.

Occurrence.—Trenton group. Bigby limestone, Versailles, Frankfort, Lexington, Benson Station, etc., Kentucky. Trenton limestone of Trenton Falls, New York. Prosser limestone of Cannon Falls and Warsaw, Minnesota. Cynthiana formation, Tennessee.

Cotypes.—Cat. Nos. 39057, 48612, 48615, 66072, 66076, 66091, U.S.N.M.

PLATYSTROPHIA AMOENA LONGICARDINALIS, new variety.

Plate 43, figs. 9-13.

The distinguishing characteristic of this variety is the great width in reference to the height. The hinge line always forms the greatest width and the cardinal extremes are acuminate and thin. The thinness is due to the compression of the slopes of both valves.

Owing to the long hinge line this variety resembles *Platystrophia trentonensis*, new species, but the plications of the latter species place it with the biplicate group of shells, while this species belongs to the triplicate group.

Measurements.—15 mm. along the hinge, 12 mm. wide across the middle, 8.2 mm. high, 7 mm. thick, 5.5 mm. sinal width, 3.8 mm. sinal depth, 1 mm. fold height.

Occurrence.—Trenton group: Prosser limestone, Oshkosh, Wisconsin; Warsaw, Fountain, and Cannon Falls, Minnesota; Curdsville limestone: Mercer County, Kentucky. Trenton limestone: Trenton Falls, New York.

Cotypes.—Cat. Nos. 24805, 66083, U.S.N.M.

PLATYSTROPHIA GLOBOSA, new species.

Plate 43, figs. 18–22.

This is a globose species with the convexity nearly equaling the width and height. The hinge line about equals the width across the middle, but it may be a little less or a little greater. The lateral slopes are abrupt. A slight compression of the slopes of the pedicle valve produces a concavity next to the cardinal angles; the fold is low and somewhat flaring toward the front; the sinus is broad and moderately deep, the depth being due to a slight elevation of the inner edges of the lateral slopes of the pedicle valve. There are three subequal plications in the sinus, four on the fold, and nine on each of the lateral slopes.

This species has the general physiognomy of *Platystrophia crassa*, but it has a low, spreading fold, is smaller, and has invariably eight or nine plications on the lateral slopes. The plications of the fold and sinus are subequal while in *Platystrophia crassa* the lateral plications of the fold and sinus are weak or have disappeared.

Measurements.—18 mm. along the hinge line, 17.7 mm. across the middle, 15.8 mm. high, 15.2 mm. thick, 11.5 mm. sinal width, 5.7 mm. sinal depth, 2 mm. fold height.

Occurrence.—Trenton group: Bigby limestone: Nashville, Tennessee. Trenton limestone: Ellisburg, New York.

Cotypes.—Cat. Nos. 66119, 66120, U.S.N.M.

PLATYSTROPHIA RHYNCHONELLIFORMIS, new species.

Plate 42, figs. 36–38.

This represents a small, short hinged, globose species with a moderately elevated and compressed fold. There are three plications in the sinus and four on the fold which have the pattern of the *TriPLICATE Group*. Six and seven plications occupy the lateral slopes. The slopes of the brachial valve are strongly convex in the umbonal region. They descend rapidly to the cardinal and lateral and less rapidly toward the frontal margin. The slopes of the pedicle valve are convex next to the sinus and become flat or concave next to the cardinal extremes.

Measurements.—7.2 mm. along the hinge line, 13 mm. wide just below the middle, 10.1 mm. high, 9.4 mm. thick, 7.2 mm. sinal width, 4.5 mm. sinal depth, 2.8 mm. fold depth.

Occurrence.—Trenton limestone at Ellisburg, New York.

Cotypes.—Cat. No. 66106, U.S.N.M.

PLATYSTROPHIA COLBIENSIS Foerste.

Plate 44, figs. 8-11.

Platystrophia colbiensis FOERSTE, Bull. Sci. Lab. Denison Univ., vol. 16, 1910, p. 55, pl. 4, figs. 2A-B.

Platystrophia of colbiensis FOERSTE, Journ. Cincinnati Soc. Nat. Hist., vol. 21, 1914, p. 131.

In the Upper Trenton of Kentucky and Tennessee occurs the species which Doctor Foerste has described as *Platystrophia colbiensis*. The fold is slightly elevated and slightly compressed; the sinus is shallow. Four subequal plications occupy the fold; they have originated by the bifurcation of the two primary plications at the beak. There are three subequal plications in the sinus; one is primary and occupies a median position; two are lateral, secondary plications which are implanted on the slopes of the sinus at about 1.5 mm. from the beak. There are 9 to 11 plications on the lateral slopes. Young specimens have subequally convex valves, but the brachial valve of older specimens is quite ventricose.

This species is larger than *Platystrophia amoena* new species and the fold is slightly compressed, while the fold of that species becomes progressively wider as it approaches the frontal margin.

Measurements.—20.6 mm. along the hinge line, 21.6 mm. wide across the middle, 15.3 mm. high, 14.4 mm. thick, 9 mm. sinal width, 6.5 mm. sinal depth, 2 mm. fold depth.

Occurrence.—Trenton group: Cynthiana limestone: Between Colby and Winchester, Paris, Lexington, Frankfort, etc., Kentucky. Catheys formation: Edgefield Junction and Nashville, Tennessee.

Plesiotypes.—Cat. Nos. 34231, 48614, U.S.N.M.

PLATYSTROPHIA COLBIENSIS-MUTATA Foerste.

Plate 44, fig. 12.

Platystrophia colbiensis mutata FOERSTE, Bull. Sci. Lab. Denison Univ., vol. 16, 1910, p. 56, pl. 4, figs. 3a-b.

Among the specimens representing *Platystrophia colbiensis* there are thinner and somewhat higher and broader shells with more than four plications on the fold and more than three in the sinus. The number varies generally from five to six on the fold and four to five in the sinus. The increase is effected by the bifurcation of the lateral plications of the fold and by implantation on the slopes of the sinus. One specimen has eight plications on the fold and seven plications in the sinus. In this case both the median and lateral plications of the fold have bifurcated and tertiary plications have been implanted on the slopes of the sinus and between the primary and secondary plications.

Occurrence.—Trenton group: Greendale beds: Pleasant Valley and Winchester, Kentucky. Catheys limestone: Nashville, Mount Pleasant, and near Gallatin, Tennessee.

Plesiotype.—Cat. No. 65914, U.S.N.M.

PLATYSTROPHIA PRECURSOR Foerste.

Plate 44, figs. 1-4, 17-20.

Platystrophia colbiensis precursor FOERSTE, Bull. Sci. Lab. Denison Univ., vol. 16, 1910, p. 57, pl. 41, fig. 1.

This abundant Upper Trenton fossil is represented by larger specimens than are usually found at this horizon. It is a transverse form with a low fold and shallow sinus bearing subequal plications. The lateral slopes are occupied by nine plications. The slopes of the brachial valve are convex in the two-thirds next to the fold, and slightly concave in the one-third next to the cardinal extremes. The slopes of the pedicle valve are convex next to the sinus and become concave next to the cardinal extremes.

Specimens having the same general aspect occur at various horizons in the Maysville and Richmond. *Platystrophia sublaticosta*, new species, of the Bellevue and Corryville beds, differs from it in having seven plications on the lateral slopes. *Platystrophia laticosta* and *Platystrophia cypha* are thicker and more compressed; they also have dwarfed lateral plications on the lateral slopes of the fold and sinus, while in this species the plications are subequal. *Platystrophia precursor* is less ventricose and has a greater height than *Platystrophia clarksvillensis* of the Waynesville formation. It has many characteristics in common with *Platystrophia annieana*, but the latter has a deeper sinus.

By selection it is possible to differentiate from among numerous specimens of *Platystrophia precursor* a small number of individuals which have a somewhat higher fold and deeper sinus. For these specimens the varietal name, *profunda* (pl. 44, figs. 17-20), is suggested.

Measurements.—27.3 mm. along the hinge line, 28 mm. wide across the middle, 18.5 mm. high, 16 mm. thick, 11.9 mm. sinal width, 6.5 mm. sinal depth, 2.7 mm. fold height.

Occurrence.—Trenton group: Cynthiana limestone: Between Colby and Winchester, and also between Millerburg and Pleasant Valley, Kentucky. Catheys formation: Nashville, Columbia, three-fourths mile east of Aspen Hill, etc., Tennessee.

Plesiotypes.—Cat. Nos. 34247, 48611, 65893, U.S.N.M.

PLATYSTROPHIA PRECURSOR LATIFORMIS, new variety.

Plate 44, figs. 5-7.

It is possible to differentiate from the typical specimens of this species a large number which are thinner and decidedly wider in proportion to the height.

Platystrophia foerstei, new species, of the Arnheim formation has the same general physiognomy, but the latter species is usually narrower and has a deeper sinus than this variety.

Measurements.—25.3 mm. along the hinge line, 22 mm. wide across the middle, 15.5 mm. high, 12.3 mm. thick, 10 mm. sinal width, 5 mm. sinal depth, 1.9 mm. fold depth.

Occurrence.—Trenton group: Catheys limestone: Nashville, Williamsport, Columbia, and Maury County, Tennessee.

Cotypes.—Cat. No. 65985, U.S.N.M.

PLATYSTROPHIA PRECURSOR ANGUSTATA, new variety.

Plate 44, figs. 13-16.

A small number of individuals may be selected from among the typical specimens which are narrower, thicker, and have a higher, more compressed fold. They have the physiognomy of *Platystrophia moritura* Cumings, of the Upper Richmond of Kentucky, Indiana, and Ohio, but are, however, narrower, have a shallower sinus and somewhat rounder plications.

Measurements.—24.3 mm. along the hinge line, 25.5 mm. wide across the middle, 18.7 mm. high, 17.5 mm. thick, 13 mm. sinal width, 10 mm. sinal depth, 45 mm. fold depth.

Occurrence.—Trenton group. Catheys limestone: Nashville, Columbia, and Tullahoma, Tennessee. Prosser limestone: Hader, Goodhue County, Minnesota (referred to this variety doubtfully).

Cotypes.—Cat. Nos. 65888, 65890, 48642, U.S.N.M.

MAYSVILLE AND RICHMOND SPECIES.

PLATYSTROPHIA JUVENIS, new species.

Plate 43, figs. 36-41.

This is a sub-equally convex transverse species with a low fold bearing four plications which originate by the bifurcation of two primary plications at the beak, and with a shallow sinus which bears three plications, of which one is primary and occupies a median position, and two are secondary implanted plications occupying lateral positions on the sinal slopes. The lateral slopes of the brachial valve are flatly convex and those of the pedicle valve flatly convex and those of the pedicle valve flatly concave. They bear seven and eight plications. The hinge line is generally somewhat less than the width across the middle but may equal this width. The cardinal areas narrow rapidly toward the cardinal extremes. The shell varies from thin to strongly convex.

Platystrophia juvenis resembles *Platystrophia pauciplicata*. Typical specimens are readily distinguished from that species by the more numerous and more closely spaced plications, and by the absence of curved lateral plications.

Measurements.—12 mm. along the hinge line, 14.5 mm. across the middle, 9.6 mm. high, 7 mm. thick, 5.4 mm. sinal width, 4.7 mm. sinal depth, 2 mm. fold depth.

Occurrence.—Maysville group. Near the base of the Fairmount beds: Newport and Covington, Kentucky.

Cotypes.—Cat. No. 65946, U.S.N.M.

PLATYSTROPHIA PAUCIPLICATA Cumings.

Plate 47, figs. 13–15.

Platystrophia lynx pauciplicata CUMINGS, Amer. Journ. Sci., ser. 4, vol. 15, 1903, p. 23, figs. 9bis.

Professor Cumings has described this small pauciplicate form from the Maysville of Cincinnati, Ohio. It varies from thin to strongly convex. The low, slightly compressed fold has four plications which result from the bifurcation of two primary plications at the beak. The shallow sinus has one median primary plication and two secondary plications which are situated on the opposite slopes of the sinus.

The hinge line is generally less than the width across the middle. The cardinal areas narrow rapidly. There are five and six plications on the lateral slopes of which the outer ones curve as they approach the lateral margins.

This species differs from *Platystrophia juvenis*, new species, in that it has fewer and more widely spaced plications, in the curvature of the plications next to the cardinal angles, and in possessing a slightly compressed fold.

So many characteristics in common between the two species suggest close relationship, and it is likely that *Platystrophia juvenis* was the direct ancestor of *Platystrophia pauciplicata* if the many intermediate forms are taken as evidence. Transitional forms suggest that *Platystrophia pauciplicata* gave rise to *Platystrophia crassa* by increase in gibbosity and decrease in relative index.¹

Measurements.—14 mm. along the hinge line, 14.9 mm. wide across the middle, 10 mm. high, 8.3 mm. thick, 7.3 mm. sinal width, 5 mm. sinal depth, 2 mm. fold depth.

Occurrence.—Maysville group: Base of the Fairmount beds, Covington, Kentucky, and Cincinnati, Ohio.

Plesiotypes.—Cat. No. 65947, U.S.N.M.

PLATYSTROPHIA STRIGOSA, new species.

Plate 43, figs. 23–26.

This name is used to designate specimens with thin valves and low spreading folds and shallow sinuses on which the lateral plications are dwarfed. The hinge-line equals or is somewhat greater than the

¹ Relative index is the length of the hinge line divided by the height.

width across the middle. The lateral slopes of the pedicle valve are flatly concave, those of the brachial valve flatly convex. There are generally six sharp plications on the lateral slopes which are broadly spaced and have a slight tendency to curve, as do the lateral plications of *Platystrophia pauciplicata*. The beak is prominent.

Measurements.—15.1 mm. along the hinge line, 14.1 mm. wide across the middle, 10.5 mm. high, 7 mm. thick, 6.5 mm. sinal width, 4.8 mm. sinal depth, 2 mm. fold depth.

Occurrence.—Maysville group: Base of the Fairmount beds at Newport, Kentucky.

Cotypes.—Cat. No. 48613, U.S.N.M.

PLATYSTROPHIA NITIDA, new species.

Plate 43, figs. 42, 43.

The specimens representing this species are small, with spreading folds which scarcely rise above the convexity of the brachial valve; and with broad shallow sinuses which have bent but slightly below the inner edges of the lateral slopes of the pedicle valve. There are six and seven fine, closely spaced plications on the lateral slopes. The slopes of the brachial valves are flatly convex while those of the pedicle valve are flatly concave. The beaks of the pedicle valves are prominent. The cardinal areas narrow rapidly and usually disappear before the cardinal extremes are reached. The hinge-line is somewhat less than the width across the middle.

Measurements.—6 mm. along the hinge line, 8.5 mm. wide across the middle, 6.2 mm. high, 3.6 mm. thick, 3.5 mm. sinal width, 1.5 mm. sinal depth, .5 mm. fold depth.

Occurrence.—Maysville group: Base of Fairmount beds at Cincinnati, Ohio.

Cotypes.—Cat. No. 65945, U.S.N.M.

PLATYSTROPHIA MORROWENSIS (James).

Plate 43, figs. 30-35, 50.

Orthis (?) *morrowensis* JAMES, Cincinnati Quart. Journ. Sci., vol. 1, 1874, p. 21.

Platystrophia morrowensis FOERSTE, Bull. Sci. Lab. Denison Univ., vol. 16, 1910, p. 60, pl. 6, figs. 11a-c.

Mr. James has applied this name to certain specimens which were collected from the Cincinnati group of Warren County, Ohio. It is a transversely globose species with sub-equally convex valves. The hinge line varies from one-third to three-fourths the width; the cardinal areas are narrow and the cardinal angles round. The fold is low and spreading; it rises very little above the general convexity of the brachial valve. The sinus is broad and shallow in the middle portion but becomes relatively deep at the front. Both the fold and sinus are almost wanting at the beak.

There are three plications in the sinus and four on the fold in the neanic stage of development. In some specimens this number is not increased during later growth. Some specimens show that in the late neanic and epebic stages plications are added by intercalation on the slopes of the sinus and bifurcation of the outer plications of the fold; or there may also be implantation in the sinus next to the primary plication and bifurcation of the median plications on the fold.

The lateral slopes of the brachial valve are convex, those of the pedicle valve are flatly concave. They are occupied by eight and nine closely spaced, round plications.

This species has the oval form and low spreading multiplicate sinus of *Platystrophia elegantula*, new species of the Trenton limestone. It is easily distinguished from that species by the ventricosity of the valves and by the shallowness of a fold and sinus next to the beak.

Measurements.—8 mm. along the hinge line, 12 mm. wide across the middle, 8 mm. high, 7 mm. thick, 6.2 mm. sinal width, 3.5 mm. sinal depth, 1 mm. fold depth.

Occurrence.—Maysville group: Corryville beds, Morrow, Cincinnati, etc., Ohio.

Plesiotypes.—Cat. Nos. 41166, 48610, U.S.N.M.

PLATYSTROPHIA CORRYVILLENSIS, new species.

Plate 43, figs. 27-29.

In the Corryville beds at Cincinnati, Ohio, is found a small, transverse, ventricose form with a long hinge line, a low-spreading fold, and broad, shallow sinus. The fold and sinus are occupied by three and four subequal plications and the lateral slopes by eight and nine rounded, closely spaced plications. The slopes of the brachial valve are convex, with a slight concavity next to the cardinal extremes; those of the pedicle valve are flatly concave. The fold rises very little above the general convexity and the sinus is only moderately deep.

Measurements.—14 mm. along the hinge line, 13 mm. wide across the middle, 9 mm. high, 7.5 mm. thick, 6.4 mm. sinal width, 3.2 mm. sinal depth, 1 mm. fold height.

Occurrence.—Maysville group: Corryville beds; Cincinnati, Ohio.

Cotypes.—Cat. No. 65926, U.S.N.M.

PLATYSTROPHIA SUBLATICOSTA, new species.

Plate 45, figs. 17-19.

At several localities a species was found which resembles *Platystrophia laticosta*, but which differ from that species in possessing a low fold throughout its life history, in being thinner and less gibbous, and in having stronger lateral plications of the fold and sinus.

This species consists of specimens of the *Platystrophia precursor* type, but differs in having a slightly higher fold and in having seven instead of nine plications on the lateral slopes.

Measurements.—29 mm. along the hinge line, 27 mm. wide across the middle, 17.5 mm. high, 14.5 mm. thick, 14.5 mm. sinal width, 7.2 mm. sinal depth, 4.5 mm. fold depth.

Occurrence.—Maysville group: Upper Fairmount to Corryville beds; Cincinnati, Ohio, and Madison, Indiana.

Cotypes.—Cat. No. 65941, U.S.N.M.

PLATYSTROPHIA ACUMINATA James.

Plate 46, figs. 5-8.

Orthis (Platystrophia) acuminata JAMES, Paleontologist, vol. 1, 1878, p. 7.

Platystrophia acuminata FOERSTE, Bull. Sci. Lab. Denison Univ., vol. 16, 1910, pl. 6, fig. 13.

This is a thin form with acuminate hinge extremities. The fold is moderately elevated and compressed, and the lateral plications on the slopes of the fold and sinus are weak. Seven to 10 plications occupy the lateral slopes.

Measurements.—19 mm. along the hinge line, 13 mm. wide across the middle, 9.5 mm. high, 7.5 mm. thick, 7 mm. sinal width, 5 mm. sinal depth, 3.7 mm. fold height.

Occurrence.—Richmond group: Arnheim formation; Waynesville, Ohio, and various localities in Kentucky.

Plesiotype.—Cat. No. 65929, U.S.N.M.

PLATYSTROPHIA FOERSTEL, new species.

Plate 46, figs. 9-12.

This species has transverse equiconvex, thin valves with a hinge line forming the greatest width and with a low spreading fold and shallow sinus which bear subequal plications. The lateral slopes of the brachial valve are flatly convex, those of the pedicle valve flatly concave.

There are generally three plications in the sinus and four on the fold, but this species in common with all other species which have low spreading folds, shows a tendency to add tertiary plications by implantation in the sinus and bifurcation on the fold. There are 8 to 10 plications on the lateral slopes.

Platystrophia foerstel resemble *Platystrophia precursor latiformis* of the Upper Trenton. It has a slightly deeper sinus than the latter form and the lateral slopes next to the sinus are somewhat higher.

Measurements.—19 mm. along the hinge line, 16.8 mm. wide across the middle, 12.7 mm. high, 9.4 mm. thick, 9.1 mm. sinal width, 5.3 mm. sinal depth, 3 mm. fold depth.

Occurrence.—Richmond group: Waynesville, Ohio, Versailles, Indiana. Arnheim formation: Branch Run, one mile east of Seatonville,

1½ miles south of Clark, etc., Kentucky. Liberty beds: Jefferson County, Kentucky.

Cotypes.—Cat. Nos. 40479, 65621, U.S.N.M.

PLATYSTROPHIA FOERSTEI AMPLA, new variety.

Plate 46, figs. 13-16.

This variety differs from typical specimens of the species in being decidedly ventricose and in having a hinge line shorter than the width across the middle.

Occurrence.—Richmond group: Arnheim formation: Lebanon, Ohio. Waynesville formation: Long Run, near mouth of Tate's Creek, and 1¼ miles southeast of Thixton, Jefferson County, and Sunset, Kentucky. Liberty beds: Ravine east of Floyd's Fork, Jefferson County, and Eastwood, Kentucky. Saluda-Whitewater formation: Weisburg, Indiana.

Cotypes.—Cat. Nos. 65635, 65636, 65637, U.S.N.M.

PLATYSTROPHIA ATTENUATA, new species.

Plate 46, figs. 1-4.

Platystrophia acutilirata CUMINGS, Amer. Journ. Sci., ser. 4, vol. 15, 1915, p. 48, fig. 25.

This species is represented by small, transverse shells with low folds and shallow sinuses, which become progressively wider toward the front and are occupied by subequal plications. Most of the specimens are thin, but some of them become decidedly convex.

The hinge line generally forms the greatest width, but it may be less than the width across the middle. The slopes of the brachial valve are flatly convex; those of the pedicle valve flatly concave. They are occupied by six to nine plications on the lateral slopes.

Compared with *Platystrophia acuminata*, it is narrower and has fewer plications. It is smaller and has a proportionately shorter hinge than *Platystrophia foerstei*. It is very similar to *Platystrophia juvenis* but has fewer lateral plications than that species. This species is scarcely distinguishable from some individuals belonging to the Middle Trenton species *Platystrophia amoena*. It generally has fewer plications, thinner valves, and stronger growth varices.

Measurements.—12 mm. along the hinge line, 13 mm. wide across the middle, 9 mm. high, 5.8 mm. thick, 5.8 mm. sinal width, 4 mm. sinal depth, 1 mm. fold height.

Occurrence.—Richmond group: Waynesville formation: Oxford and Warren County, Ohio; Simpsonville, Kentucky; East Fork White River, Indiana.

Cotypes.—Cat. No. 41167, U.S.N.M.

PLATYSTROPHIA CLARKSVILLENSIS Foerste.

Plate 45, figs. 1-4.

Platystrophia clarksvillensis FOERSTE, Bull. Sci. Lab. Denison Univ., vol. 16, 1910, p. 65, pl. 3, figs. 3, 4.

Platystrophia lynx var. *laticosta* CUMINGS, 32d. Ann. Rep. Dep. Geol. Nat. Res. Indiana, 1903, pl. 35, figs. 2, 2a, 2b; Amer. Journ. Sci., ser. 4, vol. 15, 1903, p. 32, fig. 17bb.

This is a transverse species which bears a marked resemblance to *Platystrophia laticosta*. It is narrower than that species and has more closely spaced, narrower, and more numerous plications on the slopes, there being seven to nine. It differs, also, from *Platystrophia laticosta* in that the slopes are somewhat fuller, which reduces the height of the fold. The lateral plications of the fold and sinus vary from somewhat weaker than the median plications to about equal to them in strength. The hinge line is generally greater in length than the width across the middle, but it may equal it or be somewhat less than the width.

Specimens with a long hinge line have the same general aspect as *Platystrophia cumingsi*, new species, but the latter has a longer hinge and has more numerous plications on the slopes.

Measurements.—25 mm. along the hinge line, 23 mm. wide across the middle, 16 mm. high, 15 mm. thick, 11 mm. sinal width, 10 mm. sinal depth, 4.5 mm. fold depth.

Occurrence.—Richmond group: Arnheim formation: Seatonville and Clark, Kentucky; Waynesville formation: Waynesville and Oregonia, Ohio; Weisburg and numerous other localities in Indiana.

Plesiotypes.—Cat. Nos. 65713, 65726, U.S.N.M.

PLATYSTROPHIA CUMINGSI, new species.

Plate 45, figs. 9-16.

Platystrophia bitorata var. *laticosta* HALL and CLARKE, Pal. New York, vol. 3, pt. 1, 1892, pl. 5B, figs. 6, 7 (not figs. 5, 8, 9).

Platystrophia acutilirata CUMINGS, Amer. Journ. Sci., ser. 4, vol. 15, 1903, p. 32, fig. 17c (in part); 32nd Ann. Rep. Dept. Geol. Nat. Res. Indiana, 1907, pl. 35, fig. 3, 3a.

In the Waynesville member of the Richmond group at Oxford and Waynesville, Ohio, and at Weisburg, Indiana, is a species of *Platystrophia* which possesses intermediate characters between *Platystrophia clarksvillensis* and *Platystrophia acutilirata*. It resembles the former species in that the fold is lower and less compressed than that of *Platystrophia laticosta* and the lateral plications on the slopes of the fold and sinus are stronger than in that species. It also has a greater degree of ventricosity. The specimens resemble *Platystrophia acutilirata* in the possession of acute cardinal extremes and

in having the lateral slopes occupied by numerous plications, there being 10 and 11 on the slopes of the average specimen.

Measurements.—32 mm. along the hinge line, 23.5 mm. wide across the middle, 16 mm. high, 16.2 mm. thick, 11 mm. sinial width, 11 mm. sinial depth, 5 mm. fold depth.

Formation and occurrence.—Richmond group: Waynesville formation: Waynesville, Oregonia and Oxford, Ohio; Weisburg, Indiana. Fernvale limestone: Wilmington, Illinois.

Cotypes.—Cat. Nos. 65699, 65700, 65702, 65703, U.S.N.M.

PLATYSTROPHIA ANNIEANA Foerste.

Plate 46, figs. 20-24.

Orthis annieana JAMES, Cat. Low. Sil. Fossils Cincinnati Group, 1871, p. 10 (nomen nudum.).

Platystrophia annieana FOERSTE, Bull. Sci. Lab. Denison Univ., vol. 16, 1910, pl. 6, fig. 14.

In the Bulletin of the Denison University (vol. 16, 1910, pl. 6, fig. 14, *a, b, c*) Doctor Foerste has figured a species to which Mr. U. P. James had given the catalogue name *Platystrophia annieana*. Figure *a* shows a form in which the hinge line forms the greatest width; figure *c* shows one in which the length of the hinge line about equals the width across the middle. Figure *b* shows a ventricose form with a rounded fold so little elevated as to hardly disturb the even convexity of the brachial valve.

I have before me about 70 specimens from the Waynesville and Liberty formations of Ohio, Indiana, and Kentucky, which undoubtedly belong to the species which he figured. In most specimens the hinge line about equals the width across the middle. I have, however, many in which the hinge line is longer than this width.

The low rounded fold is occupied by four and the sinus by three nearly equal plications. The sinus is moderately deep. The slopes are occupied by 10 and 11 plications. Those of the brachial valve are convex with a slight concavity next to the cardinal angles. The slopes of the pedicle valve are concave.

Measurements.—33.5 mm. along the hinge line, 28.4 mm. wide across the middle, 18.5 mm. high, 14.6 mm. thick, 14 mm. sinial width, 8.4 mm. sinial depth, 2.5 mm. fold depth.

Occurrence.—Richmond group: Waynesville formation: Clarksville, Fort Ancient, Waynesville, Ohio; Bardstown, Kentucky. Liberty beds: Jefferson County, Kentucky, and Clark County, Indiana. Whitewater formation: Richmond, Indiana.

Plesiotypes.—Cat. Nos. 39041, 65651, 65664, U.S.N.M.

PLATYSTROPHIA MORITURA Cumings.

Plate 46, figs. 25-28.

Platystrophia lynx CUMINGS, Amer. Journ. Sci., ser. 4, vol. 15, 1903, p. 24.*Platystrophia lynx* var. *moritura* CUMINGS, 32d Ann. Rept. Dept. Geol. Nat. Res. Indiana, 1908, p. 920, pl. 35, fig. 5, 5a.

This is a transverse ventricose form with a hinge line longer than the width across the middle. The brachial valve is inflated toward the umbo; the lateral slopes are convex with a slight tendency toward concavity next to the cardinal angles. The slopes of the pedicle valve are slightly concave. The fold ranges in elevation from low with subequal plications to moderately elevated with the two median plications somewhat stronger than the laterals. The sinus is deep in front. The transverse forms are restricted to the Upper Richmond, but subquadrate forms, which evidently belong to this species, are common in the Liberty beds of Kentucky and Indiana. This narrow variety seems to represent transitional forms between this species and *Platystrophia annieana*.

Measurement of a wide specimen.—30 mm. along the hinge line, 29 mm. wide, 20.5 mm. high, 21 mm. thick, 14 mm. sinal width, 14 mm. sinal depth, 5 mm. fold height.

Occurrence.—Richmond group: Whitewater formation: Richmond and northern Ripley County, Indiana. Liberty beds: Railroad cut just east of Eastwood, one-fourth mile east of Fisherville, Kentucky.

Plesiotypes.—Cat. Nos. 65671, 65674, U.S.N.M.

PLATYSTROPHIA ACUTILIRATA (Conrad).

Plate 45, figs. 20-21.

Deltopyris acutilirata CONRAD, Journ. Acad. Nat. Sci. Phila., vol. 8, 1842, p. 260, pl. 14, fig. 15.*Orthis (Platystrophia) acutilirata* MEEK, Pal. Ohio, vol. 1, 1873, p. 119, pl. 10, fig. 5.*Orthis biforata* var. *acutilirata* WHITE (part), 2nd Ann. Rept. Indiana Bur. Stat. and Geol., 1880, p. 487, pl. 2, figs. 5-9; 10th Rept. State Geol. Indiana, 1881, p. 119, pl. 2, figs. 5-9.*Orthis acutilirata* MILLER, Cincinnati Quart. Jour. Sci., vol. 2, 1875, p. 28.*Orthis (Platystrophia) biforata* var. *acutilirata* LESLEY, Geol. Sur. Penna., Rept. p. 4, 1889, p. 508, figs.*Platystrophia acutilirata* HALL and CLARKE, Pal. New York, vol. 8, pt. 1, 1892, p. 223.—FOERSTE, Amer. Geol., vol. 31, 1903, p. 340.—CUMINGS, Amer. Journ. Sci., ser. 4, vol. 15, 1903, pp. 33, 35, fig. 18 (part), p. 36, fig. 19 (part).—GRABAU and SHIMER, North Amer. Index Fossils, vol. 1, 1907, p. 258, fig. 308f.—CUMINGS, 32nd Ann. Rept. Dept. Geol. Nat. Res. Indiana, 1908, p. 912, pl. 35, fig. 3-3d (part).—FOERSTE, Bull. Sci. Lab. Denison Univ., vol. 16, 1910, p. 65, pl. 3, figs. 6, 7, 8a-b; pl. 4, fig. 9.*Platystrophia acutilirata senex* CUMINGS, 32nd Ann. Rept. Dept. Geol. Nat. Res. Indiana, 1908, p. 913, pl. 35, fig. 4 (not 4a-c).—? *Spirifer shepardi* CASTELNAU, Essai Syst. Sil. Amer. Sept., 1843, p. 42, pl. 14, fig. 15.

This species is spiriferoid, much extended on the hinge. The brachial valve is strongly ventricose; the slopes are inflated to such a degree that the fold rises but slightly above the general convexity. The pedicle valve is less convex than the brachial valve. The slopes are compressed and the inner edges are elevated. This gives a thin appearance to the shell near the cardinal angles and adds to the depth of the conspicuous sinus. There are four plications on the fold and three in the sinus which are of about equal strength. The slopes are occupied by about 13 or more closely spaced plications. The cardinal areas of both valves are strong and broad. The beaks are strongly incurved.

This species has conspicuous gerontic characters. The convexity is so great that it may equal or exceed the height. The shell is thickened centrally and anteriorly to such a degree that the space occupied by the soft parts is exceedingly small when compared with the size of the shell. Both valves are marked by strong growth lines which in the early epehebic stage run out to the cardinal extremes and are closely spaced.

Mr. Conrad reported the Silurian of the Falls of the Ohio as the locality from which his types were collected. Mr. Meek¹ recognized that his figures were in agreement with specimens from Richmond, Indiana. Mr. S. S. Lyon, of Jeffersonville, Indiana, who was familiar with the paleontology of that locality, reported that he had never found such a shell in that area. Mr. Meek sent the Richmond specimens to Mr. Conrad and he identified them as the same as he had figured under the name *Delthyris acutilirata*.

Measurements.—35.5 mm. along the hinge line, 27 mm. wide across the middle, 18.2 mm. high, 20.8 mm. thick, 13.3 mm. sinial width, 11 mm. sinial depth, 4 mm. fold height.

Occurrence.—Richmond group: Whitewater formation: Richmond, etc., Indiana; Oxford and Dayton, Ohio; North Carolina and Louisville R. R. between Wauhatchie and Hooker, Tennessee. Fernvale limestone: Savannah and Wilmington, Illinois. Maquoketa shale: Delafield, Wisconsin.

Plesiotypes.—Cat. No. 48606, U.S.N.M.

PLATYSTROPHIA ACUTILIRATA PROLONGATA Foerste.

Plate 45, fig. 22.

Platystrophia acutilirata, CUMINGS Amer. Journ. Sci., ser. 4, vol. 15, 1903, p. 35, fig. 18 (part); 32nd Ann. Rept. Dept. Geol. Nat. Res. Indiana, 1908, pl. 35, figs. 3b, c, d.

Platystrophia acutilirata prolongata, FOERSTE, Bull. Sci. Lab. Denison Univ., vol. 16, 1910, p. 67, pl. 3, figs. 8a-b.

One of the conspicuous variations of *Platystrophia acutilirata* is represented by specimens which have elongated hinge lines and a

¹ Meek, Pal. Ohio, vol. 1, 1873, p. 119, pl. 10, fig. 5.

correspondingly greater number of plications on the lateral slopes, there being from 18 to 30 or more. The acuminate cardinal extremes are so thickened as to be entirely filled with shelly deposit.

Measurements.—43 mm. along the hinge line, 25.6 mm. wide across the middle, 17 mm. high, 15.7 mm. thick, 12 mm. sinal width, 8 mm. sinal depth, 2.8 mm. fold height.

Occurrence.—Richmond group: Whitewater: Usually found associated with typical *Platystrophia acutilirata*.

Plesiotypes.—Cat. No. 65688, U.S.N.M.

PLATYSTROPHIA ACUTILIRATA SENEX Cumings.

Plate 45, fig. 23.

Orthis inflata? JAMES, Cat. Lower Sil. Fos. of the Cincinnati Group, 1871, p. 10 (*nomen nudum*).

Orthis biforata var. *acutilirata* LESLEY (part) Geol. Surv. Pennsylvania, Rept. P. 4, 1889, p. 508, figs. 5c, 5f.

Platystrophia acutilirata GRABAU and SHIMER, North American Index Fossils, vol. 1, 1907, p. 257, figs. e, y, h, i.

Platystrophia acutilirata CUMINGS, Amer. Journ. Sci., ser. 4, vol. 15, 1903, p. 35, fig. 18 (part).

Platystrophia acutilirata var. *senex* (part) CUMINGS, 32nd Ann. Rept. Dept. Geol. Nat. Res. Indiana, 1908, p. 913, pl. 35, figs. 4a-c.

Platystrophia acutilirata inflata Foerste, Bull. Sci. Lab. Denison Univ., vol. 16, 1910, pl. 4, fig. 8.

This variety is represented by specimens which possess retrogressive characters. It passes through an acuminate development in late neanic and early ephebic stages, and then becomes very convex, the depth often exceeding the height. The thickening of the shell and growth varices are more pronounced than in typical specimens. The change in contour is decidedly marked.

Measurements.—35.5 mm. along the hinge line, 38 mm. across the middle, 25 mm. thick, 25.5 mm. high, 14 mm. sinal width, 14.5 mm. sinal depth, 3 mm. fold height.

Occurrence.—Richmond group: Upper part of the Whitewater formation: Found associated with *Platystrophia acutilirata*.

Plesiotype.—Cat. No. 65691, U.S.N.M.

PLATYSTROPHIA ELKHORNENSIS, new species.

Plate 46, figs. 17-19.

From the Elkhorn member of the Richmond along Elkhorn Creek, Wayne County, Indiana, were collected two specimens of a short-hinged-globose form with a deep sinus and moderately elevated fold. The slopes are abrupt. Those of the brachial valve are regularly convex; those of the pedicle valve are slightly flattened toward the cardinal angles. There are three plications in the sinus and four on the fold, the two outer ones in each case being the weakest. There

are six and seven plications on the lateral slopes. The surface is marked by strong concentric growth lines.

Measurements.—13 mm. along the hinge line, 22.5 mm. wide just below the middle (this the the greatest width), 18 mm. high, 16.8 mm. thick, 13.5 mm. sinal width, 10.5 mm. sinal depth, 3.3 mm. fold depth.

Occurrence.—Richmond: Elkhorn division: Elkhorn Creek, Wayne County, Indiana.

Holotype.—Cat. No. 48657, U.S.N.M.

b. **PONDEROSA SUBGROUP.**

PLATYSTROPHIA PREPONDEROSA, new species.

Plate 49, figs. 6-8.

Two Upper Trenton specimens suggest the large globose forms of the genus which occur so abundantly in certain horizons of the Maysville and Lower Richmond, to which Doctor Foerste has given the the name *Platystrophia ponderosa*.

In each the fold is moderately high and compressed. It is occupied by four subequal plications which originate by the bifurcation of two primary plications at the beak. The sinus is moderately deep. It is occupied by three plications of which one is primary and occupies a median position; two are secondary, implanted plications, and occupy positions on the lateral slopes.

The thickness nearly equals the height. The hinge line equals or is somewhat less than the width across the middle. The slopes of the brachial valve are convex; those of the pedicle valve are convex next to the sinus and become slightly concave toward the cardinal angles. They are occupied by eight and nine sharp plications.

Measurements.—24 mm. along the hinge line (in one specimen the hinge line equals the width across the middle), 26.7 mm. wide across the middle, 20 mm. high, 20 mm. thick, 13 mm. sinal width, 12.5 mm. sinal depth, 6 mm. fold depth.

Occurrence.—Trenton group: Catheys limestone: 2 miles west of Nashville, Tennessee.

Cotypes.—Cat. No. 65871, U.S.N.M.

PLATYSTROPHIA PONDEROSA Foerste.

Plate 49, figs. 1-5, plate 50, figs. 4-7; plate 51, figs. 1-5, plate 52, figs. 1-3, 7-10.

Platystrophia lynx (part) of AUTHORS.

Platystrophia biforata (part) of AUTHORS.

Platystrophia ponderosa FOERSTE, Bull. Sci. Lab., Denison Univ., vol. 14, 1909, p. 225, pl. 4, fig. 14; Ohio Naturalist, vol. 12, 1912, p. 453, pl. 22, fig. 11.

Foerste describes his species as follows:

Platystrophia ponderosa is characterized by large size, thick valves, and quadrangular outline; the brachial valve has a prominent, though rather rounded, median fold,

usually occupied by four plications. The sinus on the pedicle valve is broad, not very deep, and is occupied usually by three plications. The lateral plications vary from seven to nine. Sometimes six occupy the median fold. The shell is greatly thickened interiorly, especially around the deep muscular scar in the pedicle valve.

Occurrence.—Maysville group: Bellevue, Madison, and numerous other localities in Indiana; Oldham County, Kentucky. Leipers: Stockett Hill, White Creek post office, Leipers Creek, etc., Tennessee, Bellevue, Cincinnati, and numerous localities in Ohio.

PLATYSTROPHIA PONDEROSA AUBURNENSIS Foerste.

Plate 49, figs. 9-12.

Platystrophia ponderosa auburnensis FOERSTE, Bull. Sci. Lab. Denison Univ., vol. 14, 1909, p. 226, pl. 4, fig. 15.

Orthis (Platystrophia) biforata var. *lynx* MEEK, Pal. Ohio, vol. 1, 1873, p. 144, pl. 10, fig. 1.—LESLEY, Geol. Surv. Penna., Rept. P. 4, 1889, p. 509.

Delthyris lynx HALL, Pal. New York, vol. 1, 1847, pl. 32*D*, figs. 1*A*, *B*.

Platystrophia biforata var. *lynx* HALL and CLARKE, Pal. New York, vol. 13, pt. 1, 1892, pp. 202, 223, pl. 5*B*, figs. 1-4.

Platystrophia lynx CUMINGS, Amer. Jour. Sci., vol. 15, 1903, p. 26, fig. 12; p. 28, fig. 14; 32d Ann. Rept. Dept. Geol. Nat. Res. Indiana, 1903, pl. 35, figs. 1*f*, 1*g*.

Platystrophia lynx HAYES and ULRICH, U. S. Geol. Surv., folio, 95, illus. sheet, 1903, figs. 21, 22.

This variety is more globose and has a much shorter hinge line than typical specimens of *Platystrophia ponderosa*. The shell is also narrower and there are fewer plications on the lateral slopes, as the number is usually five or six, becoming obsolete toward the cardinal angles.

Occurrence.—Maysville: Mount Auburn, Cincinnati, etc., Ohio; Madison, etc., Indiana; Oldham County, Kentucky.

Plesiotypes.—Cat. Nos. 65863, 65864, 65867, U.S.N.M.

PLATYSTROPHIA PONDEROSA ARNHEIMENSIS, new variety.

Plate 51, figs. 6-8.

This variety is large, more transverse, and has broader plications on the lateral slopes than the Bellevue form of this species.

Occurrence.—Richmond group Arnheim: Various localities in Jefferson County, Kentucky.

Cotypes.—Cat. Nos. 65854, 65855, 65856, U. S. N. M.

PLATYSTROPHIA FERVALENSIS, new species.

Plate 50, figs. 1-3.

Dr. E. O. Ulrich collected from the Fernvale at Cape Girardeau, Missouri, a large form of which the finely striated surface is the most conspicuous feature. The portion next to the beak has the characteristic coarse plications. As they extend toward the front the plications of both valves bifurcate and other plications are implanted in the original grooves. Toward the front the original plications

are represented by broad, shallow undulations which bear the fine striations.

The lateral slopes of the brachial valve are evenly convex and the fold rises but slightly above the convexity; those of the pedicle valve are convex next to the sinus but become concave toward the cardinal angles. The sinus is almost lacking at the beak, but becomes moderately deep at the front.

There are three plications in the sinus at the beak. Owing to poor preservation the plication pattern is not determinable, but the greater strength of the median plications suggests that it belongs to the *Triplicate Type*. At a distance of $5 \pm$ mm. from the beak, the plications begin to break up and form a finely striated sinus. The brachial valves were so poorly preserved that little could be determined about the plication pattern of the fold except that it was finely striated.

Measurements.—27 mm. along the hinge, 35.5 wide across the middle, and 37 mm. high.

Occurrence.—Richmond Group. Fernvale limestone: Old Quarry southeast of Regenhardt's quarry northwest of Cape Girardeau, Missouri.

Cotypes.—Cat. No. 65872, U.S.N.M.

C. HIGH FOLD SUBGROUP.

PLATYSTROPHIA PROFUNDOSULCATA (Meek).

Plate 47, figs. 16-18.

Orthis (Platystrophia) laticosta var. *profundosulcata* (James) MEEK, Pal. Ohio, vol. 1, 1873, p. 117, pl. 10, figs. 2a-d.

Orthis biforata LESLEY Geol. Surv. Pennsylvania, Rept. P. 4, 1889, p. 508, figs. 2a, 2b.

Platystrophia profundosulcata FOERSTE, Bull. Sci. Lab. Denison Univ., vol. 16, 1910, p. 58, pl. 6, figs. 15a-c.

Platystrophia lynx var. *laticosta* CUMINGS (part), 32nd Ann. Rept. Dept. Geol. and Nat. Res. Indiana, 1907, pp. 918, 919.

Platystrophia profundosulcata is smaller and more gibbous than *Platystrophia laticosta*. The sinus is more profound and the fold higher than specimens of that species of the same size. The sinus bends down so rapidly as to truncate the fold before it has reached as far forward as in other species of the genus.

The hinge line is generally shorter than the width across the middle; in rare cases it may slightly exceed it. The slopes of the pedicle valve are convex next to the sinus and strongly concave near the cardinal extremes; those of the brachial valve are convex. They descend rapidly to the lateral margin and less rapidly to the frontal margin.

The strength of the lateral plications of the fold and sinus varies from subequal to much weaker than the median plications. Four

plications occupy the fold which originate by the bifurcation of two primary plications at the beak. There are three plications in the sinus; one is primary and occupies a median position, two are lateral secondary plications which have been implanted on the slopes of the sinus. The lateral slopes are occupied by five, six, or seven sharp widely spaced plications.

Measurements.—18 mm. along the hinge line, 20.5 mm. wide across the middle, 13 mm. high, 12.5 mm. thick, 8.4 mm. sinal width, 9 mm. sinal depth, 3.6 mm. fold depth.

Occurrence.—Maysville group: Mount Hope and Fairmount beds at Cincinnati, Ohio; Newport, Kentucky; Hays Branch, Indiana, etc.

Plesiotypes.—Cat. No. 65923. U.S.N.M.

PLATYSTROPHIA PROFUNDOSULCATA HOPENSIS Foerste.

Plate 47, figs. 19-21.

Platystrophia profundosulcata hopensis FOERSTE, Bull. Sci. Lab. Denison Univ., vol. 16, 1910, pl. 4, fig. 4.

This variety is more transverse, has a lower fold and shallower sinus than typical specimens of the Mount Hope and Fairmount beds. They are more like young *Platystrophia laticosta*, but the sinus is deeper. The physiognomy of the shell throughout its development suggests that this variety is the ancestor of the forms which Meek took as the types of the species.

Measurements.—19.5 mm. along the hinge, 20.5 mm. wide across the middle, 11.8 mm. high, 13 mm. thick, 10 mm. sinal width, 9 mm. sinal depth, 3.3 mm. fold height.

Occurrence.—Maysville group: Mount Hope beds, Cincinnati, Ohio and Covington, Kentucky.

Plesiotypes.—Cat. No. 65924, U.S.N.M.

PLATYSTROPHIA CRASSA (James).

Plate 47, figs. 1-11.

Orthis (Platystrophia) dentata? MEEK (not Pander) Pal. Ohio, vol. 1, 1873, p. 117, pl. 10, fig. 3.

Orthis (Platystrophia) crassa JAMES, Cincinnati Quart. Journ. Sci., vol. 1, 1874, p. 20.

Orthis dentata MILLER, Cincinnati Quart. Journ. Sci., vol. 2, 1875, p. 27.

Orthis costata MILLER (not Pander) Cincinnati Quart. Journ. Sci., vol. 2, 1875, p. 33.

Platystrophia crassa HALL and CLARKE, Pal., New York, vol. 8, pt. 1, 1892, p. 223.—GRABAU and SHIMER, North American Index Fossils, vol. 1, 1907, p. 258, figs. 308A-B.—FOERSTE, Bull. Sci. Lab. Denison Univ., vol. 16, 1910, p. 59, pl. 4, figs. 5a-b.

Orthis (Platystrophia) biforata dentata LESLEY, Geol. Surv. Pennsylvania, Report P. 4, 1889, p. 508, figs. 3a-d.

Orthis centrosa MILLER, North Amer. Geol. and Pal., 1889, p. 356.

Platystrophia biforata var. *crassa* WINCHELL and SCHUCHERT, Geol. Minnesota, vol. 3, 1893, p. 458, pl. 33, figs. 55, 56.—WHITEAVES, Palaeozoic Fossils, vol. 3, pt. 3, Geol. Surv. of Canada, 1897, p. 178.

Platystrophia costata CUMINGS and MAUCK, Amer. Journ. Sci., ser. 4, vol. 14, 1902, p. 14, foot note.—CUMINGS, Amer. Journ. Sci., ser. 4, vol. 15, 1903, pp. 38, 122, figs. 26, 27; 32nd Ann. Rept. Dept. Geol. Nat. Res. Indiana, 1908, p. 914, pl. 35, figs. 6, 6a.

In 1873 Meek described specimens which he had received wrongly labeled as *Platystrophia dentata* Pander. He expressed doubt as to their agreement with the British specimens of *Platystrophia dentata* which are described by McCoy. In 1874 James described this form as *Platystrophia crassa*.

The hinge line is generally somewhat shorter than the width across the middle; in some specimens it is longer than this width. The lateral slopes are swollen next to the fold and sinus and descend rapidly to the free margins. Those of the brachial valve are strongly convex, while those of the pedicle valves are concave toward the cardinal extremes.

James took as his types specimens with high compressed folds and profound sinuses on which the lateral plications were rudimentary or absent. By far the greater number have a compressed, moderately elevated fold with lateral plications somewhat weaker than the median plications, but reaching to the free edge.

In all mature and old specimens the inner edges of the lateral slopes of the pedicle valve are elevated to such a degree as to form a profound sinus. Gibbosity becomes so pronounced in old specimens that the thickness exceeds the height and may equal or nearly equal the width.

The shell is narrower and more globose than that of *Platystrophia laticosta* and *Platystrophia cypha*. It is somewhat like *Platystrophia unicostata crassiformis*, new variety, but it has a lower fold than that form. It also has a greater number of plications on the lateral slopes, as there are seven and eight in this species and only five and six in *Platystrophia unicostata crassiformis*. By selection it is possible to differentiate, from among numerous specimens, a small number of individuals which are shorter and thicker than other members of the species.

It is also possible to differentiate an occasional pauciplicate form with a hinge line decidedly shorter than the other specimens. There are four, rarely five and six, coarse, sharp, and broadly spaced plications on the lateral slopes. Specimens representing this mutation are smaller than other members of the species.

Occurrence.—Maysville group: All mutations are found in association in the Fairmount beds at Cincinnati, Ohio; Covington, Kentucky; and Madison, Indiana, etc.

Plesiotypes.—Cat. Nos. 35566, 48604, U.S.N.M.

PLATYSTROPHIA CRASSA, variety.

Plate 47, figs. 12.

Specimens have been found in the Arnheim and Waynesville at several localities which closely resemble *Platystrophia crassa*. The only characteristic which seems to distinguish these from the Fairmount specimens is their somewhat longer hinge line.

Measurements.—15 mm. along the hinge, 16.8 mm. wide across the middle, 15.5 mm. high, 12.6 mm. thick, 9.3 mm. sinial width, 7.2 mm. sinial depth, 4 mm. fold depth.

Occurrence.—Richmond group, Waynesville formation: Mouth of Bull Creek, Clark County, Indiana; Greenwell Ford, Kentucky. Arnheim: One and one-half miles south of Clark, Jefferson County, Kentucky.

Plesiotype.—Cat. No. 65953, U.S.N.M.

PLATYSTROPHIA LATICOSTA (Meek).

Plate 48, figs. 11-13.

Delthyris lynx HALL, Pal. New York, vol. 1, 1847, pl. 32*D*, figs. 1 *O*, *P*, *Q*.

Orthis laticostata JAMES, Cat. Sil. Foss. Cincinnati Group, 1871, p. 10 (*nomen nudum*).—MILLER, Cincinnati Quart. Jour. Sci., vol. 2, 1875, p. 27.

Orthis (Platystrophia) biforata var. *laticosta* MEEK, Pal. Ohio, vol. 1, 1873, p. 116, pl. 10, fig. 4.—LESLEY, Geol. Surv. Pennsylvania, Rep. P. 4, 1889, p. 509, figs. 4*a-d*.

Platystrophia biforata var. *laticosta* HALL and CLARKE, Pal. New York, vol. 8, pt. 1, 1892, p. 223, pl. 5*B*, figs. 5, 8, 9 (not 6, 7).

Platystrophia lynx var. *laticosta* CUMINGS and MAUCK, Amer. Journ. Sci., ser. 4, vol. 14, 1902, p. 4.—CUMINGS (part), Amer. Journ. Sci., ser. 4, vol. 15, 1903, p. 28 (footnote) p. 29, figs. *e-e'''*.

Platystrophia laticosta CUMINGS (part), Amer. Journ. Sci., vol. 15, 1903, pp. 30, 122.

Platystrophia laticosta FOERSTE, Amer. Geol., vol. 31, 1903, p. 334.—GRABAU and SHIMER, N. A. Index Fossils, vol. 1, 1907, p. 258.—FOERSTE, Bull. Sci. Lab. Denison Univ., vol. 16, 1910, pl. 3, figs. 1*a*, *b*, 2.

Platystrophia laticosta has a transverse shell with seven plications on the lateral slopes. The fold is compressed and the sinus deep. The depth of the sinus is increased by elevation of the inner edges of the lateral slopes of the pedicle valve, which is the result of lateral compression.

The slopes of the brachial valve have a convex curve from the front to the cardinal margin with the steepest part of the curve toward the hinge. The curve from the edge of the fold to the lateral margin is flatly convex.

The chief distinction between *Platystrophia laticosta* and *Platystrophia cypha* is one of degree. Both have high compressed folds and deep sinuses, but there is less compression of the fold and less depth to the sinus in the former. The lengthwise convexity of the

lateral slopes is also less in *Platystrophia laticosta* than in *Platystrophia cypha*.

The lateral plications of the fold and sinus are weak, but they have never entirely disappeared. Specimens of *Platystrophia cypha* often have one or both of these plications entirely missing.

Similar specimens occur in the Waynesville beds. The latter, are ventricose, more transverse and bear nine instead of seven plications on the lateral slopes.

Occurrence.—Maysville group. Leipers formation: Nashville, Tennessee. Bellevue member: Maysville, Bullittsville, and Oldham County, Kentucky; Madison, Vevay, Lawrenceburg and Manchester, Indiana. Bellevue and Corryville beds: Cincinnati and elsewhere in Ohio.

Plesiotypes.—Cat. Nos. 48605, 50946, U.S.N.M.

PLATYSTROPHIA UNICOSTATA Cumings.

Plate 48, figs. 4-7.

Platystrophia unicostata CUMINGS, Amer. Journ. Sci., ser. 4, vol. 15, 1903, pp. 28-29, figs. 15 a-d, p. 31.—FOERSTE, Bull. Sci. Lab. Denison Univ., vol. 16, 1910, pl. 4, fig. 6.

Professor Cumings has described this form as a uniplicate *Platystrophia laticosta* of the Upper Maysville. It differs from that species in that it is more compressed, is narrower and has a higher fold and deeper sinus.

The compression, the high fold, and deep sinus and loss of lateral plications of the fold and sinus agree with *Platystrophia cypha* as do also the contour of the lateral slopes. The slopes of the brachial valve bend rapidly toward the cardinal margin, somewhat less rapidly to the frontal margin, and with almost no bend to the lateral margin. The slopes of the pedicle valve are profoundly elevated along the inner margins which descend with a decided slope and form a deep concavity.

This species differs from *Platystrophia cypha* in that the hinge line is not more than one-fourth greater than the width across the middle and the lateral plications are fewer, coarser and more widely spaced, as there are only five and six. Specimens in the United States National Museum labeled by James as *Platystrophia cypha* belong to this species. James took as his types of *Platystrophia cypha* shells which were conspicuously prolonged along the hinge-line and with 10 or 12 plications on each of the lateral slopes.

Platystrophia unicostata is connected with *Platystrophia laticosta* by all degrees of variants. Some individuals have three plications on the sinus and four on the fold; in this case the lateral plications are

very weak. Some individuals have one lateral plication on the fold and one in the sinus fairly well developed, while those on the opposite side merely appear or are entirely absent. The loss of these plications is due to obsolescence. Among the specimens in Columbia University there were several which showed this loss to be due to retardation in development, but none of the specimens belonging to the National Museum show this and the Columbia specimens are not regarded as representative.

Measurements.—28.5 mm. along the hinge line, 24 mm. wide across the middle, 18.3 mm. high, 22 mm. thick, 13 mm. sinal width, 16 mm. sinal depth, 6 mm. fold depth.

Occurrence.—Maysville Group. Bellevue: Madison and Vevay, Indiana; Maysville: Near Lebanon, Kentucky. Corryville: Cincinnati, Ohio.

Plesiotypes.—Cat. Nos. 39037, 65968, 65969, 65970, U.S.N.M.

PLATYSTROPHIA UNICOSTATA CRASSIFORMIS, new variety.

Plate 48, figs. 8-10.

This variety is represented by narrow gibbous specimens which show strong lateral compression. The hinge line equals or is greater than the width across the middle. The fold is narrow and strongly elevated; the sinus is profound. In most specimens there are two plications on the fold and one in the sinus, but in other specimens there is one weak lateral plication on one or both sides of the fold and sinus. The lateral slopes of the brachial valve are strongly convex, those of the pedicle valve strongly concave. The slopes are occupied by four to six plications.

This variety has been confused with *Platystrophia crassa*. It has a more angular outline, the fold is higher, the sinus deeper, and the lateral plications are broader and more broadly spaced. It is narrower than *Platystrophia unicostata*. The many characteristics in common between this variety and *Platystrophia cypha* would indicate that it belonged to that species, but the growth stages and many variants point to *Platystrophia laticosta* as the stock from which this variety developed.

Measurements.—25 mm. along the hinge line, 22.2 mm. wide across the middle, 17.1 mm. high, 19 mm. thick, 11.5 mm. sinal width, 11.5 mm. sinal depth, 4.5 mm. fold depth.

Occurrence.—Maysville group. Leipers formation; Boodlettsville, Tennessee. Bellevue member: Maysville, Kentucky; Bellevue; Madison, Indiana.

Cotypes.—Cat. No. 65965, U.S.N.M.

PLATYSTROPHIA CYPHA (James)

Plate 47, figs. 22-25; plate 48, figs. 14-16.

Delthyris lynx HALL, Pal. New York, vol. 1, pl. 32D, figs. 1 R. S. T. U.*Orthis (Platystrophia) cypha* JAMES, Cincinnati Quart. Jour. Sci., vol. 1, 1874, p. 20; not figured.*Platystrophia cypha* CUMINGS, Amer. Journ. Sci., ser. 4, vol. 15, 1903, p. 39, footnote.—FOERSTE, Amer. Geol., vol. 31, 1903, p. 341; Bull. Sci. Lab. Denison Univ., vol. 16, 1910, p. 61, pl. 4, fig. 10a-b; pl. 5, fig. 11; pl. 4, fig. 12; Ohio Naturalist, vol. 12, 1912, p. 453, pl. 22, fig. 5.*Platystrophia lynx* var. *cypha* CUMINGS, 32nd Ann. Rept. Dept. Geol. Nat. Res. Indiana, 1908, p. 917.

Mr. James described this species as a transverse gibbous form with a hinge so long as to form spinelike projections; a profound sinus; a remarkably elevated fold; convexity equaling the width across the middle; one strong plication in the sinus and an obscure rudimentary one on each side; and twenty-two to twenty-six angular costae on each valve.

Doctor Foerste saw the specimens preserved in the James collection in the Walker Museum of Chicago University as types of *Platystrophia cypha*. He says:¹

The one numbered 2326 * * * is prolonged conspicuously along the hinge line; it possesses 12 plications; on one side of the shell extend to about three-quarters of an inch from the beak. The spinelike prolongation at the opposite end of the hinge line has been broken off. The other specimens can not be regarded as types since in these the prolongation of the shell along the hinge line does not exceed an eighth of an inch and the number of plications on each side of the fold is 7 or 8 instead of 10 or 12. Although all of these specimens can not be regarded as original types, they evidently belong to the same species if my interpretation of the species is correct.

I have before me about 200 specimens of this species, and those which apply to this description are found at various horizons of the Arnheim of Tennessee, Kentucky, Ohio, and Indiana. I have one specimen from the Arnheim of Lebanon, Kentucky, which seems to agree in dimensions with those which Mr. James took as his types. It is 40 mm. along the hinge and 23.5 mm. wide across the middle. There are 12 plications on the lateral slopes. This specimen, however, has four plications in the sinus and five on the fold. Individuals of nearly every species of the triplicate group have been found which have more than three plications in the sinus and four on the fold, and this specimen represents one of these mutations.

The average individual of these Arnheim forms has a hinge line which is about one-fourth greater than the width across the middle, and has 9 or 10 plications on the lateral slopes. The high compressed fold has two strong and two weak plications; the profound sinus has a strong median plication and two weak lateral plications.

¹ Bull. Sci. Lab. Denison Univ., vol. 16, 1910, p. 62.

The slopes of the brachial valve have a strongly convex curve from the cardinal to the frontal margin. There is only a slight convex curve from the fold to the lateral margins. The slopes of the pedicle valve are strongly concave, the greatest concavity being behind the cardinal angles. Specimens with fewer lateral plications which are found associated with those just described are placed in this species as they are in agreement in all other characters.

Doctor Foerste has applied the name *Platystrophia cypha conradi* (see pl. 47, figs. 26, 27, Cat. No. 66028, U.S.N.M.) to that type of shell which is much prolonged along the hinge-line, bears numerous plications on the lateral slopes, and has a less compressed fold and sinus which bears stronger lateral plications than is found in typical specimens of *Platystrophia cypha*.

Platystrophia cypha resembles *Platystrophia unicosata* and *Platystrophia unicosata crassiformis*. The chief difference lies in its greater width and correspondingly greater number of plications on the lateral slopes.

Measurements.—33 mm. along the hinge, 25.5 mm. wide across the middle, 17.5 mm. high, 17.5 mm. thick, 13.5 mm. sinal width, 11.5 mm. sinal depth, 6 mm. fold depth.

Occurrence.—Richmond group: Arnheim formation: Waynesville and Lebanon, Ohio; Seatonville, Bardstown, Lebanon, near Springfield, Fisherville, etc., Kentucky; and Madison, Indiana.

Plesiotypes.—Cat. Nos. 66001, 66009, U.S.N.M.

PLATYSTROPHIA CYPHA TUMIDA, new variety.

Plate 48, figs. 17-20.

Among the specimens of *Platystrophia cypha* found in the Arnheim of Tennessee, Kentucky, Ohio, and Indiana occurs a variety with a tumid shell in which the thickness equals the width across the middle and equals or exceeds the height. The hinge line forms the greatest width. Four specimens from Mount Washington, Kentucky, have the hinge line greatly extended but in most specimens it is about a third greater than the width across the middle. The fold is high and slightly less compressed than in typical specimens of the species. The sinus is profound in front and has a direction at right angles to the direction of the posterior portion of the sinus. The lateral plications of the fold and sinus are on the average relatively strong but they are always weaker than the median plications. The number of plications on the lateral slopes vary from 8 to 10.

The slopes of the brachial valve are swollen. The descent in all directions is abrupt, but it is most abrupt toward the cardinal margin. The lateral slopes of the pedicle valve are greatly elevated next to the sinus. Strong compression of this valve has resulted in a decidedly concave outline.

Compared with *Platystrophia wallowayi* this form has more acuminate cardinal extremes with concave rather than convex lateral margins. The slopes of the brachial valve are more tumid and those of the pedicle valve more compressed than in the latter species. It has many of the characteristics of *Platystrophia unicostata*. The slopes of the brachial valve are more swollen and those of the pedicle valve more compressed than that form and it also has a greater number of plications on the slopes.

The inflated brachial valve suggests relationship to *Platystrophia clerksvillensis* and *Platystrophia cumingsi* and the stratigraphic position of the three forms strengthens this view, but this variety marks the culmination of a development toward decrease in width and increase in thickness. It would not be likely to give rise to species whose development was toward increase in the width of the shell.

Measurements.—33.5 mm. along the hinge line, 25.9 mm. wide across the middle, 19.3 mm. high, 25 mm. thick, 16.8 mm. sinal width, 16 mm. sinal depth, 6.5 mm. fold height.

Occurrence.—Richmond group: Arnheim formation: One mile south of Mount Washington, Greenwell Ford, 1½ miles south of Clark, etc., Kentucky; 4 miles northeast of Gallatin and Goodlettsville, Tennessee; Waynesville and Clarksville, Ohio; Southeastern Indiana.

Holotype.—Cat. No. 66069, U.S.N.M.

PLATYSTROPHIA CYPHA ARCTA, new variety.

Plate 48, figs. 1-3.

Another variant of *Platystrophia cypha* has a thinner valve and a more compressed fold and sinus than other members of the species and the lateral plications on the slopes of the fold and sinus are weak. Sometimes they become obsolete before reaching the frontal margin. Most of the specimens have subquadrate cardinal extremes; a few specimens are slightly elongate on the hinge-line. The convexity of the brachial valve and concavity of the pedicle valve are not so marked as in other members of the species. Nine and ten closely spaced plications occupy the lateral slopes.

This variety is easily distinguished by its thin fold, narrow form, and closely spaced plications.

Measurements.—35 mm. along the hinge line, 33 mm. wide across the middle, 17.5 mm. high, 13.5 mm. thick, 12 mm. sinal width, 9.5 mm. sinal depth, 6 mm. fold depth.

Occurrence.—Richmond group. Arnheim formation: Wyoming, Sunset, ¼ mile east of Fisherville, Clark, Greenwell Ford Section, Bullitt County, Kentucky; Gallatin, Tennessee; Waynesville, Ohio.

Cotypes.—Cat. No. 66045, U.S.N.M.

PLATYSTROPHIA CYPHA BELLATULA, new variety.

Plate 47, figs. 28-30.

In the Waynesville formation of Ohio and Kentucky there is a small variety of *Platystrophia cypha* with six, seven, or eight plications on the lateral slopes. This variety has many characteristics in common with *Platystrophia unicostata*. It is smaller and shorter than that species, and has somewhat narrower plications on the lateral slopes.

Measurements.—25.2 mm. along the hinge line, 21.5 mm. wide across the middle, 14 mm. high, 17 mm. thick, 9.5 mm. sinal width, 13 mm. sinal depth, 4.5 mm. fold depth.

Occurrence.—Richmond group: Waynesville formation; Waynesville and Clarksville, Ohio; Westport, Kentucky.

Cotypes.—Cat. No. 66021, U.S.N.M.

PLATYSTROPHIA WALLOWAYI Foerste.

Plate 45, figs. 5-8.

Platystrophia wallowayi FOERSTE, Ohio Naturalist, vol. 12, 1912, p. 453, pl. 22, fig. 6.

This represents a globose form with a hinge line somewhat shorter than the width across the middle, a high, broad, rounded fold and broad deep sinus. The brachial valve is strongly convex. The pedicle valve is not as deep as the brachial valve; it is convex next to the sinus, but becomes slightly concave toward the cardinal angles. There are usually four plications on the fold and three in the sinus but in some specimens there are five or more plications on the fold and four or more in the sinus. There are usually 9 or 10 plications on the lateral slopes. Mature specimens have strong growth lines.

Measurements.—19 mm. along the hinge line, 22.6 mm. wide below the middle (greatest width), 17.3 mm. high, 17.2 mm. thick, 13.7 mm. sinal width, 11.3 mm. sinal depth, 6.7 mm. fold height.

Occurrence.—Richmond group: Arnheim formation: Walloway Creek, near Boston, Bardstown, etc., Kentucky; Southeastern Indiana.

Plesiotypes.—Cat. Nos. 39043, 65981, U.S.N.M.

EXPLANATION OF PLATES.

PLATE 42.

All figures on this plate are natural size.

FIGS. 1, 2. *Platystrophia uniplicate*, new species. p. 405.

1. Pedicle valve showing one plication in the sinus.

2. Brachial valve. The low fold bearing two plications is typical (same specimen as fig. 1).

Trenton limestone near Lake Champlain, New York.

FIGS. 3-6. *Platystrophia trentonensis*, new species, p. 407.

3. Pedicle valve. The figure shows the presence of three plications in the sinus.

4. Pedicle valve of a long-hinged specimen.

Trenton group (Prosser limestone) Decorah, Iowa.

5. Brachial valve showing the bifurcation of the median plication.

6. Anterior view.

Trenton group (Prosser limestone). Fountain, Minnesota.

FIGS. 7, 8. *Platystrophia precdens*, new species, p. 405.

7. Pedicle valve showing two plications in the sinus merging into one at the beak.

Trenton group (Curdsville limestone), Mercer County, Kentucky.

8. Pedicle valve of a plump specimen. The presence of one plication in the sinus at the beak is shown.

Trenton limestone near Lake Champlain, New York.

FIGS. 9-11. *Platystrophia trentonensis champlainensis*, new variety, p. 407.

9. Pedicle valve. The biplicate plication pattern is well shown.

10. Cardinal view showing the short hinge line.

11. Brachial valve. The figure illustrates the bifurcation of the median plication.

Trenton limestone near Lake Champlain, New York.

FIGS. 12-14. *Platystrophia trentonensis perplana*, new variety, p. 407.

12. Pedicle valve showing the intercalation of a median plication in the sinus.

13. Cardinal view. The thin form is typical.

Trenton group (Curdsville limestone), Crossville Quadrangle, Tennessee.

14. Brachial valve. The figure shows the biplicate arrangement of the plications of the fold.

Trenton group (Curdsville limestone), Mercer County, Kentucky.

FIGS. 15-19. *Platystrophia hermitagensis*, new species, p. 409.

15. Pedicle valve showing the broad shallow sinus.

Trenton group (Hermitage limestone), Payton's Creek, 6 miles northwest of Carthage, Tennessee.

16. Brachial valve showing the low multiplicate fold.

17. Pedicle valve. This specimen lacks the usual median plication in the sinus.

18. Anterior view. The thin form is characteristic.

19. Cardinal view. The presence of two plications on the fold at the beak is shown in this figure.

Trenton group (Hermitage limestone), Auburn, Tennessee.

FIG. 20. *Platystrophia*, species.

20. A specimen of the Biplicate Group with two plications in the sinus. Only one valve was found.

Trenton group (Prosser limestone), Cannon Falls, Minnesota.

FIGS. 21, 22. *Platystrophia regularis* Shaler, p. 405.

21. Pedicle valve showing the two plications in the sinus. The outer margin has been broken away.

22. Brachial valve partly buried in limestone. The three plications on the fold are typical.

Richmond group (Ellis Bay), Cliff, one-half mile east of Junction Cliff, Anticosti Island.

FIG. 23. *Platystrophia reversata* (Foerste), p. 408.

23. Pedicle valve showing the multiplicate sinus. The outer edges have been broken away.

Albion group (Brassfield limestone), Dayton, Ohio.

FIG. 24. *Platystrophia daytonensis* (Foerste), p. 406.

24. Brachial valve. The three plications on the fold are typical.

Albion group (Brassfield limestone), Nelson County, Kentucky.

FIGS. 25-28. *Platystrophia brachynota* (Hall). p. 408.

25. Cardinal view illustrating the short hinge.

26. Brachial valve of the same specimen. The figure shows the five plications on the fold.

Niagarian group (Louisville limestone), Louisville, Kentucky.

27. Pedicle valve. The presence of four plications in the sinus is characteristic.

28. Brachial valve of a small specimen.

Albion group (Brassfield limestone), Nelson County, Kentucky.

FIGS. 29-31. *Platystrophia*, species.

29. Brachial valve. The fold scarcely rises above the general convex outline.

30. Cardinal view.

31. Pedicle valve. The shallow sinus is characteristic. The plication pattern of the fold and sinus shows that this species belongs to the biplicate group.

Middle Ordovician (Wesenberg limestone), near Wesenberg, Esthonia, Russia.

FIGS. 32-35. *Platystrophia*, species.

32. Cardinal view showing the short hinge-line and globose form.

33. Brachial valve. The three plications of the fold is typical. The varices are so strong as to be almost lamellose.

34. Pedicle valve.

35. Anterior view. This species has two plications in the sinus. The plication pattern of the fold and sinus places this species in the biplicate group.

Upper Ordovician (Fl) Kurküll, Russia.

FIGS. 36-38. *Platystrophia rhynchonelliformis*, new species, p. 413.

36. Brachial valve showing a compressed fold.

37. Pedicle valve. The triplicate arrangement of the plications of the sinus is typical.

38. Cardinal view. The short hinge line is typical.

Trenton limestone Ellisburg, New York.

FIGS. 39-41. *Platystrophia extensa*, new species, p. 410.

39. Pedicle valve showing the triplicate plication pattern.

Trenton group (Hermitage limestone), two miles north of Hartsville, Tennessee.

40. Cardinal view. The thin valves are characteristic.

41. Brachial valve.

Trenton group (Hermitage limestone), Auburn, Tennessee.

FIGS. 42-43. *Platystrophia daytonensis laurelensis*, new variety, p. 406.

42. Brachial valve showing the presence of three plications on the fold.

43. Pedicle valve. The two plications in the sinus show the biplicate arrangement.

Niagara group (Laurel limestone), St. Paul, Indiana.

PLATE 43.

All figures on this plate are natural size.

FIGS. 1-8. *Platystrophia amoena*, new species, p. 412.

1. Brachial valve. The figure shows the low spreading fold.

Trenton group (Bigby limestone), Cynthiana, Kentucky.

2. Brachial valve of a mutation which has six plications on the fold.

3. Brachial valve of a normal individual.

Trenton limestone, Trenton Falls, New York.

4. Brachial valve of a narrow specimen.

5. Anterior view showing the low fold, shallow sinus and thin valves.

6. Pedicle valve of a normal individual.

Trenton group (Bigby limestone), Versailles, Kentucky.

7. Pedicle valve of a mutation which has four plications in the sinus.

8. Brachial valve of a normal individual.

Trenton group (Bigby limestone), Frankfort, Kentucky.

FIGS. 9-13. *Platystrophia amoena longicardinalis*, new variety, p. 412.

9. Pedicle valve. The figure shows the shallow sinus.
10. Brachial valve. The low spreading fold is typical.
Trenton limestone, Trenton Falls, New York.
- 11, 12. Brachial valves.
13. Cardinal view showing the ventricosity. All the specimens show the characteristic acuminate hinge extremities,
Trenton group (Prosser limestone), Fountain, Minnesota.

FIGS. 14-17. *Platystrophia amoena robusta*, new variety, p. 412.

14. Cardinal view. The plump form is characteristic.
15. Pedicle valve. The shallow sinus is illustrated.
16. Anterior view. The figure illustrates the shallow sinus.
17. Brachial valve showing the characteristic strong growth lines.
Trenton limestone, Trenton Falls, New York.

FIGS. 18-22. *Platystrophia globosa*, new species, p. 413.

18. Pedicle valve. The triplicate plication pattern is well shown.
19. Cardinal view. The plump form is typical.
20. Anterior view showing the broad sinus.
21. Brachial valve illustrating the broad low fold.
Trenton group, Nashville, Tennessee.
22. Brachial valve.
Trenton limestone, Ellisburg, New York.

FIGS. 23-26. *Platystrophia strigosa*, new species, p. 417.

23. Anterior view showing the typical thin form, low fold and shallow sinus.
24. Pedicle valve. The broad sharp plications are characteristic.
25. Brachial valve, of a mutation with five plications on the fold.
26. Brachial valve of a somewhat larger specimen.
Maysville group (Fairmount), Newport, Kentucky.

FIGS. 27-29. *Platystrophia corryvillensis*, new species, p. 419.

27. Cardinal view showing the ventricose brachial valve and long hinge line.
28. Brachial valve. The fold scarcely rises above the general convexity of the valves.
29. Pedicle valve. The broad sinus is typical.
Maysville group (Corryville beds), Cincinnati, Ohio.

FIGS. 30-35. *Platystrophia morrowensis* (James), p. 418.

30. Lateral view. The globose form is characteristic.
31. Pedicle valve showing the low spreading fold.
32. Cardinal view. The short hinge line is characteristic.
33. Pedicle valve of an individual with three plications in the sinus.
Maysville group (Corryville beds), Morrow, Cincinnati, etc., Ohio.
34. Pedicle valve of a longer hinged individual.
35. Brachial valve of a very short hinged specimen.
Maysville group (Corryville beds), Cincinnati, Ohio.

FIGS. 36-41. *Platystrophia juvenis*, new species, p. 416.

36. Brachial valve of a typical specimen.
37. Brachial valve of a mutation with seven plications on the lateral slopes.
38. Pedicle valve of a mutation which approaches *Platystrophia pauciplicata*.
39. Pedicle valve of a typical specimen.
40. Anterior view showing the even convexity of the valves.
41. A group attached to a bryozoan frond.
Maysville group (Fairmount beds), Newport and Covington, Kentucky.

FIGS. 42-43. *Platystrophia nitida*, new species, p. 418.

42. Brachial valve showing the characteristic low spreading fold.
43. Cardinal view. The short hinge line is characteristic.
Maysville group (Fairmount), Cincinnati, Ohio.

- FIGS. 44-47. *Platystrophia elegantula*, new species, p. 410.
44. Pedicle valve. The multiplicate sinus is characteristic.
 45. Cardinal view showing the short hinge.
 46. Brachial valve. The outer plications are shown to curve.
 47. Anterior view. This species has a low rounded fold and broad sinus. These specimens show the characteristic multiplicate sinus.
Trenton group (Bigby limestone), Frankfort, Kentucky.
- FIG. 48. *Platystrophia elegantula triplicata*, new variety, p. 411.
48. Pedicle valve showing the presence of only three plications in the sinus.
Trenton limestone, Ellisburg, New York.
- FIG. 49. *Platystrophia elegantula amplisulcata*, new variety, p. 411.
49. Pedicle valve with seven plications in the sinus.
Trenton group (Bigby limestone), Frankfort, Kentucky.
- FIG. 50. Portion of the outer surface of a *Platystrophia morrowensis* James, showing the granular character.

PLATE 44.

All figures on this plate are natural size.

- FIGS. 1-4. *Platystrophia precursor* Foerste, p. 415.
1. Brachial valve. This figure shows the subequal plications on the fold.
 2. Pedicle valve. The broad sinus is typical.
 3. Anterior view showing the broad, moderately deep sinus.
 4. Cardinal view showing the equiconvex valves.
Trenton group (Catheys formation), Nashville, Tennessee.
- FIGS. 5-7. *Platystrophia precursor latiformis*, new variety, p. 415.
5. Cardinal view showing the long hinge line.
 6. Pedicle valve. The triplicate plication pattern is well shown.
 7. Brachial valve.
Trenton group (Catheys formation), Nashville, Tennessee.
- FIGS. 8-11. *Platystrophia colbiensis* Foerste, p. 414.
8. Brachial valve of an average individual.
 9. Pedicle valve of an average individual.
Trenton group (Catheys formation), Edgefield Junction, Tennessee.
 10. Pedicle valve of a large specimen.
 11. Brachial valve of same specimen.
Trenton group (Catheys formation), Nashville, Tennessee.
- FIG. 12. *Platystrophia colbiensis mutata* Foerste, p. 414.
12. Pedicle valve showing five plications in the sinus.
Trenton group, 4 miles east of Mount Pleasant, Tennessee.
- FIGS. 13-16. *Platystrophia precursor angusta*, new variety, p. 416.
13. Brachial valve of a specimen which is referred to this variety.
Trenton group (Prosser limestone), Hader, Goodhue County, Minnesota.
 14. Pedicle valve showing the typical narrow form.
 15. Brachial valve of another specimen.
 16. Anterior view. The figure shows the thick valves.
Trenton group (Catheys formation), Nashville, Tennessee.
- FIGS. 17-20. *Platystrophia precursor profunda*, new variety, p. 415.
17. Pedicle valve. The figure shows a deep sinus.
 18. Brachial valve. The broad fold is characteristic.
 19. Cardinal view showing the brachial valve to be deeper than the pedicle valve.
 20. Anterior view. The deep sinus is characteristic.
Trenton group (Catheys formation), Nashville, Tennessee.

PLATE 45.

All figures on this plate are natural size.

FIGS. 1-4. *Platystrophia clarksvillensis* Foerste, p. 422.

1. Cardinal view showing the extended hinge line.
2. Pedicle valve. The specimen shows the subequal plications in the sinus.
3. Anterior view. The prominent sinus is characteristic.
Richmond group (Waynesville formation), Waynesville, Ohio.
4. Brachial valve.
Richmond group (Waynesville formation), Oregonia, Ohio.

FIGS. 5-8. *Platystrophia wallowayi* Foerste, p. 438.

5. Anterior view showing the great depth of the sinus.
Richmond group (Arnheim), Southeastern Indiana.
6. Lateral view. The robust form is characteristic.
7. Brachial valve. The figure shows the typical strong varices.
8. Pedicle valve of a mutation with four plications in the sinus.
Richmond group (Arnheim). Long Run, three-fourths mile above Boston,
Jefferson County, Kentucky.

FIGS. 9-13. *Platystrophia cumingsi*, new species, p. 422.

9. Pedicle valve. The figure represents an average specimen.
Richmond group (Waynesville formation), Oxford, Butler County, Ohio.
10. Cardinal view. The ventricose form is characteristic.
Richmond group (Waynesville formation), Oregonia, Ohio.
11. Brachial valve showing the strong plications on the slopes of the fold.
12. Anterior view of a mutation which has four plications in the sinus.
Richmond group (Waynesville formation), Waynesville, Ohio.
13. Brachial valve. The right side has been crushed.
Richmond group (Fernvale limestone), Wilmington, Illinois.

FIGS. 14-16. *Platystrophia* cf. *cumingsi*, new species, p. 422.

14. Anterior view showing shallow sinus, low fold and thin valves.
15. Pedicle valve. The extended cardinal extremes is characteristic.
16. Brachial valve.
Richmond group, near Waynesville, Ohio.

FIGS. 17-19. *Platystrophia sublaticosta*, new species, p. 419.

17. Anterior view. The shallow sinus and low fold are typical.
18. Brachial valve showing the strong plications on the slopes of the fold.
19. Pedicle valve. (Same specimen as fig. 17.)
Maysville group (Upper Fairmount), Cincinnati, Ohio.

FIGS. 20-21. *Platystrophia acutilirata* (Conrad), p. 424.

20. Interior of pedicle valve.
21. Brachial valve. The low broad fold is typical.
Richmond group (Whitewater), Richmond, Indiana.

FIG. 22. *Platystrophia acutilirata prolongata* Foerste, p. 425.

22. Pedicle valve showing the extended cardinal extremities.
Richmond group (Whitewater formation), Richmond, Indiana.

FIG. 23. *Platystrophia acutilirata senex* Cumings, p. 426.

23. Brachial valve. The narrow form is characteristic.
Richmond group (Upper Whitewater formation), Richmond, Indiana.

PLATE 46.

All the figures on this plate are natural size.

FIGS. 1-4. *Platystrophia attenuata*, new species, p. 421.

1. Pedicle valve. The figure illustrates the broad shallow sinus.
2. Anterior view showing the characteristic thin form.

FIG. 3. Brachial valve. The low spreading fold is typical.

4. Brachial valve with nine plications on the lateral slopes.

Richmond group (Waynesville formation), Warren County, Ohio.

FIGS. 5-8. *Platystrophia acuminata* (James) p. 420.

5. Brachial valve showing the slightly elevated fold.

6. Brachial valve. The acuminate cardinal extreme are characteristic.

7. Pedicle valve. The plications on the slopes of the sinus have almost disappeared.

8. Posterior view of the shell.

Richmond group (Arnheim formation), Waynesville, Ohio.

FIGS. 9-12. *Platystrophia foerstei*, new species, p. 420.

9. Posterior view showing the long hinge-line.

Richmond Group Waynesville, Ohio.

10. Pedicle valve. The somewhat extended cardinal extremes are well illustrated.

Richmond group (Liberty beds), just east of Eastwood, Jefferson County, Kentucky.

11. Pedicle valve of a narrow specimen.

12. Brachial valve. The broad fold is typical.

Richmond group (Arnheim formation), 1 mile east of Seatonville, Kentucky.

FIGS. 13-16. *Platystrophia foerstei ampla*, new variety, p. 421.

13. Brachial valve of an average specimen.

Richmond group (Liberty), Ravine East of Floyd's Fork, Jefferson County, Kentucky.

14. Posterior view showing the ventricose form.

Richmond Group (Waynesville formation), Long Run near mouth of Tates Creek, Jefferson County, Kentucky.

15. Pedicle valve.

16. Brachial valve.

Richmond group (Waynesville), $1\frac{1}{4}$ miles southeast of Thixton, Jefferson County, Kentucky.

FIGS. 17-19. *Platystrophia elkhornensis*, new species p. 426.

17. Pedicle valve. The figure shows the strong growth varices.

18. Cardinal view showing the short hinge line and globose form.

19. Brachial valve.

Richmond group (Elkhorn Division), Elkhorn Creek, Richmond, Indiana.

FIGS. 20-24. *Platystrophia annieana* Foerste, p. 423.

20. Anterior view of a narrow specimen. The even convexity is characteristic.

Richmond group (Whitewater formation), Richmond, Indiana.

21. Pedicle valve. A mutation with five plications in the sinus.

22. Brachial valve of an average specimen.

23. Brachial valve. (Same specimen as fig. 21.)

Richmond group (Waynesville formation), Waynesville, Ohio.

24. Anterior view. This specimen has a higher fold than the average.

Richmond group, 1 mile east of Bradstown, Kentucky.

FIGS. 25-28. *Platystrophia moritura* Cumings, p. 424.

25. Brachial valve.

26. Anterior view showing the deep sinus.

Richmond group (Whitewater beds), Ripley County, Indiana.

27. Anterior view of a robust specimen. The slightly compressed fold is characteristic.

28. Pedicle valve. This figure represents a mutation with five plications in the sinus and six on the fold.

Richmond group (Liberty beds), railroad cut just northwest of Eastwood, Kentucky.

PLATE 47.

All figures on this plate are natural size.

FIGS. 1-11. *Platystrophia crassa* (James), p. 430.

1. Brachial valve.
2. Pedicle valve.
3. Lateral view. The gibbous form is typical.
4. Posterior view.
5. Pedicle valve of a short thick mutation.
6. Anterior view of a short thick mutation.
7. Anterior view of a specimen with a high fold bearing dwarfed lateral plications.
8. Pedicle valve of a high fold specimen.
9. Brachial valve. A specimen with a high fold bearing weak lateral plications.
10. Cardinal view of a short-hinged mutation.
11. Anterior view showing the deep sinus.
Maysville (Upper Fairmount), Cincinnati, Ohio; Covington, Kentucky.

FIG. 12. *Platystrophia crassa*, variety p. 432.

12. Brachial valve.
Richmond (Arnheim), 1½ miles south of Clark, Kentucky.

FIGS. 13-15. *Platystrophia pauciplicata* Cumings, p. 417.

13. Pedicle valve. The lateral slopes bear six plications.
14. Anterior view. Showing the thin valves.
15. Brachial valve. The fold is slightly elevated.
Maysville (Basal Fairmount), Covington, Kentucky.

FIGS. 16-18. *Platystrophia profundosulcata* (Meek), p. 429.

16. Brachial valve of a narrow specimen.
17. Pedicle valve showing the characteristic transverse form.
18. Anterior view. The profound sinus is typical.
Maysville (Basal Fairmount), Cincinnati, Ohio.

FIGS. 19-21. *Platystrophia profundosulcata hopensis* Foerste p. 430.

19. Pedicle valve showing the decidedly transverse form.
20. Brachial valve showing the prominent fold.
21. Anterior view.
Maysville (Mount Hope), Cincinnati, Ohio.

FIGS. 22-25. *Platystrophia cypha* James, p. 435.

22. Brachial valve showing the characteristic broad form.
23. Anterior view. The profound sinus is typical.
24. Pedicle valve which shows the extended hinge-line.
Richmond group (Arnheim formation), Waynesville, Ohio.
25. Anterior view showing the height of the fold. Richmond group (Arnheim formation), 1 mile east of Seatonville, Kentucky.

FIGS. 26-27. *Platystrophia cypha conradi* Foerste, p. 436.

26. Brachial valve.
27. Pedicle valve. The lateral plications of the fold are strong.
Richmond group (Arnheim formation), one-fourth mile northeast of Seatonville, Kentucky.

FIGS. 28-30. *Platystrophia cypha bellatula*, new variety, p. 438.

28. Brachial valve.
29. Anterior view.
30. Pedicle valve showing the characteristic narrow form.
Richmond group (Waynesville formation), Waynesville, Ohio.

PLATE 48.

All figures on this plate are natural size.

FIGS. 1-3. *Platystrophia cypha arcta*, new variety, p. 437.

1. Pedicle valve.
2. Anterior view showing the deep sinus.
3. Brachial valve. (Same specimen as fig. 2.) These figures show the characteristic narrow form.

Richmond group (Arnheim formation), Greenwell Ford Section, Bullitt County, Kentucky.

FIGS. 4-7. *Platystrophia univcostata* Cumings, p. 433.

4. Pedicle valve. The specimen has only two plications in the sinus. Maysville group (Bellevue member), Madison, Indiana.
5. Cardinal view showing the somewhat extended cardinal extremes. Maysville group, Southeastern Indiana.
6. Brachial valve. The high compressed fold bearing weak lateral plications is typical.

Maysville group, Lebanon, Kentucky.

7. Anterior view showing the characteristic profound sinus. Corryville, Cincinnati, Ohio.

FIGS. 8-10. *Platystrophia univcostata crassiformis*, new variety, p. 434.

8. Anterior view. Showing the presence of one strong and two weak plications in the sinus.
9. Brachial valve. The high compressed fold is characteristic.
10. Pedicle valve.

These specimens show the typical narrow valves.

Mayesville group (Bellevue member), Madison, Indiana.

FIGS. 11-13. *Platystrophia laticosta* (Meek), p. 432.

11. Anterior view. The high fold and profound sinus are typical. Maysville (Bellevue), Oldham County, Kentucky.
12. Pedicle valve.
13. Brachial valve showing weak plications on the slopes of the fold. Maysville (Corryville beds), Cincinnati, Ohio.

FIGS. 14-16. *Platystrophia cypha*, variety.

14. Anterior view.
15. Pedicle valve.
16. Brachial valve.

Richmond group (Waynesville), Madison, Indiana.

FIGS. 17-20. *Platystrophia cypha tumida*, new variety, p. 436.

17. Brachial valve.
18. Pedicle valve.
19. Anterior view showing the great depth of the sinus.
20. Cardinal view. The tumid appearance is characteristic.

Richmond group (Arnheim formation), Southeastern Indiana.

PLATE 49.

All figures on this plate are natural size.

FIGS. 1-5. *Platystrophia ponderosa* Forst., p. 427.

1. Cardinal view of an immature specimen.
3. Pedicle valve of an immature specimen.
5. Pedicle valve of a mature specimen. Maysville group (Bellevue), Madison, Indiana.
2. Brachial valve of a specimen which is referred to this species. Maysville group (Leipers formation), Leipers Creek, Tennessee.
4. Interior view of pedicle valve. Maysville group, Oldham County, Kentucky.

FIGS. 6-8. *Platystrophia preponderosa*, new species, p. 427.

6. Pedicle valve. This figure shows a moderately deep sinus.

7. Brachial valve with a moderately elevated fold.

8. Cardinal view showing the globose form.

Trenton group (Catheys limestone), 2 miles west of Nashville, Tennessee.

FIGS. 9-12. *Platystrophia ponderosa auburnensis* Foerste, p. 428.

9. Cardinal view showing the shortened hinge-line and globose form.

10. Brachial valve. The well-marked growth lines are characteristic.

Maysville group (Mount Auburn), Cincinnati, Ohio.

11. Pedicle valve.

Maysville group (Mount Auburn) Oldham County, Kentucky.

12. Cardinal view of an immature specimen.

Maysville group (Mount Auburn), Madison, Indiana.

PLATE 50.

All figures on this plate are natural size.

FIGS. 1-3. *Platystrophia fernvaleensis*, new species, p. 428.

1. Interior of pedicle valve showing the deep muscle scar.

2. Pedicle valve. The coarse plications at the beak split into striae as they approach the margins.

3. Brachial valve. The low fold is typical.

The outer margins of these specimens are broken away.

Richmond group (Fernvale limestone), Old Quarry southeast of Regenhardt's Quarry at the northwest edge of Cape Girardeau, Missouri.

FIGS. 4-7. *Platystrophia ponderosa*, variety.

4. Cardinal view. The figure illustrates the short hinge and globose form.

5. Brachial valve showing curved plications next to the cardinal angles. (Same specimen as fig. 4.)

Richmond group (Arnheim formation), near Bakers, Tennessee.

6. Pedicle valve showing the broad round sinus.

Richmond group (Arnheim) east of Long Run Sta., Jefferson County, Ky.

7. Pedicle valve of a mutation with seven plications in the sinus.

Richmond group (Arnheim formation), Long Run, south of Eastwood, Kentucky.

This type of shell seems to be confined to the Arnheim member of the Richmond group.

FIGS. 8-11. *Platystrophia*, species.

8. Pedicle valve showing the broad shallow sinus.

9. Cardinal view. The extended hinge line is characteristic.

10. Brachial valve. The figure illustrates the low, broad fold.

11. Anterior view. The even convexity of the pedicle valve is shown.

Maysville group (Bellevue member), Madison, Indiana.

12. Cardinal view of a subquadrate mutation.

13. Brachial valve of the same specimen.

14. Pedicle valve of the same type of shell.

15. Lateral view of the same specimen.

Maysville group (Mount Auburn), Cincinnati, Ohio.

PLATE 51.

FIGS. 1-5. *Platystrophia ponderosa*, variety.

1. Brachial valve showing the loss of slope on the left side of fold.

Richmond group (Arnheim formation), on Floyd's Fork, 1 mile northeast of Seatonville, Kentucky.

2. Brachial valve of a decidedly asymmetrical form.

- FIG. 3. Brachial valve in which the differentiation between the fold and right slope is lost.
4. Pedicle valve of the same specimen.
Richmond group (Arnheim formation), Brush Run, 1 mile east of Seatonville, Kentucky.
5. Brachial valve of a specimen in which the fold is asymmetrical.
Richmond group (Arnheim formation), one-fourth mile east of Fisherville, Kentucky.
- FIGS. 6-8. *Platystrophia ponderosa arnheimensis*, new variety, p. 428.
6. Anterior view. The thick valves and coarse pliations are characteristic.
Richmond group (Arnheim formation), 1½ miles west of Clark, Kentucky.
7. Pedicle valve of a mutation with four plications in the sinus.
Richmond group (Arnheim formation), Brush Run, 1 mile east of Seatonville, Kentucky.
8. Brachial valve of a specimen with a short hinge.
Richmond group (Arnheim formation), Long Run, three-fourths mile above Boston, Kentucky.

PLATE 52.

All figures on this plate are natural size.

- FIGS. 1-3. *Platystrophia ponderosa*, variety.
1. Brachial valve of a mutation with five plications on the fold.
2. Cardinal view.
3. Pedicle valve. (Same specimen as fig. 1.) The illustration shows four plications in the sinus.
This variety is characterized by its transverse form.
Richmond group (Arnheim formation), one-fourth mile east of Fisherville, Kentucky.
- FIGS. 4-6. *Platystrophia*, species.
4. Cardinal view.
6. Pedicle valve. This variety has a broad shallow sinus and acuminate hinge **extremes**.
This form has many characters in common with those illustrated in plate 50, figs. 5, 8-11.
Richmond group (Arnheim formation), 1 mile east of Seatonville, Kentucky, on Floyd's Fork.
5. Brachial valve showing the low rounded fold.
Richmond group, Lebanon, Ohio.
- FIGS. 7. *Platystrophia ponderosa* Foerste.
Interior view showing the deep muscle scars and the articulation.
Maysville group (Bellevue member), Madison, Indiana.
- FIGS. 8-9. *Platystrophia ponderosa*, variety.
8. Anterior view of a similar specimen.
Richmond group (Arnheim formation), 1 mile east of Seatonville, Kentucky.
9. Brachial valve of a mutation with seven plications on the fold.
Richmond group, 4 miles northeast of Gallatin, Tennessee.
- FIG. 10. *Platystrophia ponderosa* Foerste.
10. Interior view of the brachial valve, *c.* cardinal area; *cp.* cardinal process; *d.* delthyrium; *m.* muscle scar; *s.* septum; *t.* teeth.
Maysville group: Cincinnati, Ohio.